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# MEMOIRS, &c.

## I. *Outlines of the Mineralogy of the Ochil Hills.*

By Charles Mackenzie, Esq. F.L.S. F.W.S., &c. Member of the Geological Society.

(*Read 14th November* 1812.)

If the true ends of science be promoted rather by careful observation than by vague hypothesis, the Geognosy of Werner has peculiar claims to admiration. Without the lofty pretensions which constitute the chief distinction of some speculations, it has established general principles, which facilitate the labours of the student, and prompt to continued exertion. A system which developes the great laws of nature, and is substantially improved by the examination of her works, is of all others the best calculated to promote every science; and accordingly we find, that mineralogy has made the most rapid advances wherever this has been fairly adopted. Formerly, mineralogical inquiries produced nothing more than a mere catalogue of localities; but now many relations of individuals have been distinctly deter-

mined; others are daily ascertained, and the most doubtful will probably be accurately known at a period not very remote. The correctness of these observations, is shewn by the history of mineralogy within a very few years, during which there has been an immense accumulation of geognostic facts collected from portions of the whole known world. In Britain alone, has the comparative progress of the science been unequal to the apparent ardour with which it has been pursued, and unworthy of the example afforded by our indefatigable and justly distinguished President. With a view of contributing as far as it is in my power to remedy this deficiency, I have examined the interesting district of the Ochil Hills; and I now beg leave to lay the general results of that examination before the Society. In many instances they will be found imperfect and unsatisfactory. It would have been gratifying, had it been possible for me to have made them more complete; but as circumstances render that wish unavailing, I trust that others, whose opportunities may be more favourable, will be prompted to retrace my steps, to correct my errors, and to add new facts to those I shall detail.

## *General Description.*

Modern geographers consider the Ochil Hills as the southern boundary of the Grampians; and in that point of view, the eastern portion may be

traced to the Seedlay Hills; while the western extremity should be regarded as a *mountain-arm* stretching into the extensive valley which reaches from the verge of the Grampians, properly so called, to the shores of the Forth: but as the present object is to give a sketch of their particular structure, without entering more into their general relations than distinctness requires, it will be convenient to view them as a *small mountain-group*, which rises above the sea-port of Parton Craigs, on the right bank of the Tay, and, after having skirted the northern parts of Fifeshire, traversed Perthshire, bounded Kinross-shire and Clackmananshire, through a course of more than fifty miles, terminates on the river Allan, near Dunblane, in Stirlingshire.

This group consists of a high chain, the loftiest point of which, at its first rise *, does not exceed three or four hundred feet; but more lofty † summits occur to the westward, until Bencleugh ‡ and Dalmyatt, rear their heads at an elevation of more



* Craig Law, above the village of Parton Craigs.

† The following are the most remarkable, going from east to west. Norman's Law, Glenduchy hills, Clachert Craig, the hills of Abernethy, Castle Law, Sea Male, King's Seat, Bencleugh, Dalmyatt; besides many others which may be traced in the map.

‡ Above the village of Westertown, &c.

than 2000 feet above the level of the sea. Several smaller chains may be traced in a course nearly parallel to that of the most elevated, particularly to the south, where they may be distinctly seen gradually diminishing, until they are lost in the adjacent valleys. In a few instances, as at the south-eastern extremity, they diverge from the general direction, forming small mountain-arms, which bound some lateral valleys of great fertility and beauty.

The individuals of which this group is composed, are generally long round-backed hills, very richly covered with verdure, having occasionally conical and rarely tabular summits. Those of the first description, are most numerous between Parton Craigs and Abernethy, and those of the latter, between Dunning and the Yetts of Muckhart; and it is worthy of remark, that the former are more completely covered up than any of the other hills.

The *acclivities* look to the north, and are generally rapid, though there are some remarkable exceptions to this observation. The *declivities* are very gentle, except at Bencleugh, where they are in many places nearly precipitous. A very large proportion of the Ochil Hills are cultivated to the very summits, and nearly the whole of the remainder are excellent pasture. The natural consequence of this is, that there are few openings, except in an accidental quarry, or some rare natu-

ral exposure *, circumstances which embarrass the mineralogist in no common degree.

The *dip* of the strata, with very few exceptions, is to the south-east, corresponding with the declivities; and the *direction* from north-east to south-west, corresponding with the direction of the whole group, which runs about half of its course from east to west, and then, changing its direction, runs from north-east to south-west.

*Springs* are very numerous throughout the whole of the Ochil Hills; in some instances they form pools, in others bogs, and in many they unite and give rise to several beautiful small streams, that meander through the neighbouring districts. The Devon, the Allan, and the May, are the most remarkable of these streamlets; and they pour their waters into the Forth, the Tay, and the Erne.

The *valleys* are also numerous, separating the several chains, and the individual heights from each other. In general they are narrow, not exceeding thirty or forty yards in width; their length depends on that of the chain, or mountain which they bound. These valleys are most numerous at the western extremity of the Ochils,



* Such is exhibited in the magnificent range of columns, which may be traced nearly from Craig-in-Crune to Clachert Crag.

where they are also most extensive. They imperceptibly diminish both in size and importance to the eastward. It is, however, in the latter portion that the romantic valley occurs, in which the Lake of Lindores is contained. In this small spot, nature has crowded together all that can delight the eye, and elevate the imagination.

The Ochil Hills are bounded to the north and north-west by the Frith of Tay, Strath-Erne, and Strath-Allan; to the south-west by the vale of Forth; to the south by the vales of Devon, of Kinross, and of Eden; and to the east by the left bank of the Eden, where it is lost in the right bank of the Tay.

The prevailing rock throughout the whole of the northern boundaries, is a dark brick-red Sandstone, which extends as far as Callendar to the west, and to Stonehaven * to the east, and is in all probability the *old red sandstone*. The independent coal formation, according to Mr Bald †, forms the coal-field of Clackmananshire and Stirlingshire; and the red sandstone, occasionally assuming the characters of conglomerate ‡, again occupies

* See Colonel Imrie on the Conglomerate, &c. vol. 1. Wernerian Memoirs.

† See Mr Bald on the coal-field of Clackmananshire, vol. 1. Wernerian Memoirs.

‡ This is distinctly the case immediately to the north of Cupar, in a small opening made by the rivulet which empties itself into the Eden below the town.

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Pitcaithly * and Dunning; and to the westward of the latter place. Its colour is a dark brick-red, brownish red, and reddish grey. It is coarse-grained, occasionally it becomes conglomerated, as to the south of Dunning, where it rests on the reddish-grey sandstone, and contains considerable masses of quartz, fine-grained sandstone, and scales of silver-white mica. This sandstone is occasionally highly crystalline, bearing some resemblance to iron-flint. When the mica predominates, it assumes a slaty character, and decomposes into tables.

It occurs distinctly stratified, dipping to the south-east, with an apparent direction from north-east to south-west. I have not seen it in connexion with any other rock, except below the Rumbling Bridge in the course of the Devon, where it alternates with a tuff; and at the foot of the King's Seat, near to the house of Harvieston †, where it rests immediately above a seam of slaty pitch-coal, six feet two inches thick. From the resemblance of its characters to those of another sandstone to be hereafter noticed, it is highly probable, that they will be found to belong to the same formation; but as they have not been traced in distinct connexion, it may be well to keep them

* This is a small village in Perthshire, celebrated for a mineral spring, to which considerable efficacy has been ascribed.

† The seat of my friend CRAUFURD TAIT, Esq.

separate at present. At the base of Alva hill, it seems to lie below greenstone.

In a small valley which traverses the Ochils, between Wormit Bay, and a lateral valley that divides Newton hill from Sanford hill, there are several small hillocks of an ironshot sand, which contains masses of this sandstone. It is probable, that they have been derived from the decomposition of the red sandstone just described.

Although it has not been accurately determined, it is highly probable, that this red sandstone, from the number of points at which it occurs, and the coincidence between its characters and those of the *old* red sandstone which occupies the adjacent valleys, that they will be hereafter found to be intimately connected. At present, I shall hesitate to fix the place of this rock in the system, and content myself with observing, that it seems to be the lowest of the series composing the Ochil Hills.

## II. *Amygdaloid.*

On the shore between Parton Craigs and Balmerino, (a district of nearly nine miles), a coarse Amygdaloid gradually passes into a finer variety of the same rock. The former of these consists chiefly of portions of the latter, binding together various substances. I could not discover the thickness of any of the beds; but I apprehend, from

having seen a different rock at a small height above it, that it is inconsiderable. The basis of this rock is a greyish-green claystone, occasionally very much ironshot. The numerous cavities contained in it, are lined with white amethyst, flesh-red calcareous spar, white felspar, chalcedony, red flint, and common quartz. The chalcedony appears to have been first deposited, and the quartz to have been the last.

The amygdaloid sometimes becomes porphyrytic, containing crystals of felspar.

It is difficult to assign to this rock its correct geognostic position. At Parton Craigs, it is below claystone porphyry. Near Newport, it alternates with basaltic clinkstone. At the western extremity of Wormit Bay, it is below the claystone, through which it seems to be connected with the tuff on the one hand, and with the claystone porphyry on the other. On the water of Fargs, which runs from Damhead * to Abernethy, it occurs resting on a variety of greenstone, which is connected with the clinkstone. In this last situation, it possesses a great variety of characters, being extremely coarse at one point, where a bed of clay-porphyry rests upon it. More to the southward, the vesicles in the amygdaloid become

* This place is about half way between Kinross and Abernethy.

very distinct, and contain a flesh-red variety of felspar.

This rock is traversed by veins of calcareous spar, which exhibit a sea-green colour, when fresh broken.

### III. *Grey Sandstone.*

Above the amygdaloid*, beds of a yellowish grey sandstone alternate with tuff and claystone, which appear to be intimately connected with some varieties of the amygdaloidal rock. It contains a considerable quantity of scales of silver-white mica, and decomposes into slaty masses. It seems to pass almost imperceptibly into the varieties of claystone to be hereafter described. One variety of this rock has a very remarkable granitic appearance, and does in fact contain all the constituents essential to true granite. At the same time, however, it retains the distinctive characters of sandstone.

The relations of this rock to the older rocks, is not clearly made out, except at Wormit Bay, where it seems to rest on amygdaloid. It occurs frequently between Wormit Bay, and the village of Dunning in Perthshire. It also occurs in the course of the Devon, where it may be seen alternating with the red sandstone, to which in all probability it belongs.

* At the western extremity of Wormit Bay.

Its general dip is to the south-east, and its direction from north-east to south-west.

## IV. *Limestone.*

In a quarry at the base of Park Hill, not far from Bambriech Castle *, a saddle-shaped mass of yellowish grey Limestone rests between beds of slate-clay and grey sandstone; and above the newest sandstone, there is a bed of greenstone, the upper part of which is much decomposed. This limestone varies from an earthy to a highly crystalline structure, resembling if not passing into calcareous spar.

This is the only instance throughout the whole of the Ochils that I have seen limestone, although I have been assured, that other portions of it have been observed at a considerable elevation above the village of Abernethy. On examining the situations to which I was referred, I could discover no traces of limestone; from which I have been induced to suspect, that the popular belief is unfounded.

---

* Bambriech Castle stands on a promontory of red sandstone, which runs a short way into the Tay, from its southern bank, about three miles to the eastward of the small sea-port of Newburgh. Immediately to the south of the castle, the Ochils rise very rapidly, and receive different names. That of Park Hill, is appropriated to the hill half way between Newburgh and Bambriech.

### V. *Slate-Clay.*

Thin seams of a bluish-grey Slate-clay, possessing the common characters, occur both above and below the limestone, separating it from the grey sandstone.

### VI. *Claystone.*

This is a very abundant rock, and some very beautiful varieties of it occur in the course of the Ochil Hills. At Lucklaw *, it appears to pass into basaltic clinkstone; below Birkhill †, it alternates with sandstone, tuff and felspar, passing on the one hand into the grey sandstone, and on the other, through all the varieties of tuff and clinkstone, to the perfectly compact felspar. It is also found between the Yetts of Muckhart and Alva, below the clinkstone, with which it probably alternates.

It is fine-grained, having a large flat conchoidal fracture, and an uneven cross fracture. It occasionally contains scales of silver-white mica, particularly where it alternates with the sandstone and tuff, as it does below Birkhill. The colour is various, even in the alternating strata; the most common, however, is between pearl grey and isa-

* This is a small hill between Cupar and Parton Craigs.

† An eminence about five miles to the westward of Woodhaven.

bella yellow. It sometimes, though rarely, is amygdaloidal: the cavities of such varieties, are filled with green earth, and white calcareous spar: crystallised felspar is dispersed throughout the mass.

The claystone alternates with the grey sandstone and the tuff, between which it is most probably the connecting link; for it passes almost imperceptibly at its extremities into each of them. It is doubtful, whether or not the claystone be of older formation than the limestone, as I have seen both in similar relations to the sandstone. The present location, therefore, of these rocks, in so far as they regard each other, must, until more extended observations shall have been made, be considered as entirely arbitrary.

## VII. *Tuff.*

A very remarkable tufacious rock occurs above the claystone at the base of Birkhill, and at the western extremity of Wormit Bay. In both of these situations, it alternates with the sandstone and claystone. In no other part of the Ochils have I observed a similar arrangement.

This tuff is coarse, inclosing portions of felspar, which is sometimes lost in the prevailing mass. The chief colours are, flesh-red and Isabella yellow. It appears to be one of the newest members of the sandstone series, and there is a gradual passage from it to the claystone. It is distinctly

stratified, having the general dip, direction, and inclination of the whole mountain-group.

## VIII. *Basaltic Clinkstone.*

From the first rise to the final termination of the Ochil Hills, Clinkstone is the prevailing rock. It occurs at Parton Craigs, resting on, and in one instance alternating with, the amygdaloid; from Craig-in-Crune, (half way between Woodhaven and Newburgh,) it forms the summits of the hills, occasionally exhibiting columns of more than 100 feet in height, which rise precipitously from the low lands on the south bank of the Tay, and produce a noble and imposing effect *. At the more western portions of this district, the clinkstone is connected with greenstone, felspar porphyry, and compact felspar. At Westertoun, immediately above the junction with the coal-field of Clackmananshire, it occurs distinctly stratified, the beds being separated from each other by thin seams of leek-green steatite, which contains iron pyrites in considerable abundance. It occasionally assumes the characters of basalt: at other times, it is more decidedly clinkstone; but it most gene-

* This is remarkably the case in the hills between Craig-in-Crune, and Norman's Law. The columns there have a diameter of from five to seven feet. They are pentagonal, as it usually happens.

rally possesses characters intermediate between those of basalt and clinkstone; from which circumstance, I have been induced to adopt the name of Basaltic Clinkstone, which applies equally to every variety.

Its colours are blackish-grey, blackish-brown, and sometimes it is much ironshot, particularly at the summits of the lower hills. Its fracture is slaty and rough, and in general it emits the clinking sound to which the species owes its name. Beautiful specimens of an amygdaloidal variety occur between Abernethy * and Kinross.

The dip and direction of the stratified portions of this clinkstone, correspond with the general dip and direction.

## IX. *Greenstone.*

Throughout the district which extends from Parton Craigs to Newburgh, the clinkstone frequently passes into greenstone; and in the immediate vicinity of the latter place, it appears distinctly columnar, though its relations to every other rock are wholly undefined.

It is not improbable, from similar greenstone being found in higher portions of the hills between Newburgh and Woodhaven, that it alternates with

* The hills in this district are very picturesque, and have (I believe) appropriate names, though I could not learn them, as every shepherd furnished one of his own.

the clinkstone. Between Dunning * and the Yetts of Muckhart, it occurs frequently above the clinkstone, and below felspar-porphyry; but is seen in greatest abundance, variety, beauty, and distinctness between the Yetts of Muckhart and the western extremity of the Ochils, particularly in an exposure made by a streamlet which divides the King's Seat from Craiginnan †, and in a section above the village of Westertoun. In this district, it forms separate hills, or their caps, and in the central parts of the group, it alternates distinctly stratified with the basaltic clinkstone, which it connects with the felspar rock through the felspar porphyry. The section above Westertoun, may be considered a beautiful epitome of these alternations, and it receives an additional interest from its exhibiting a fine view of the junctions of the Coal-field, with the newer rocks. The beds of greenstone have a dip and direction at right angles, to the dip and direction of the clinkstone, from which it is separated by thin seams of

* The observation made on the hills between Abernethy and Kinross, applies to those of the above portion of the Ochil Hills. The confusion arising from a perpetual repetition of names, has induced me, in many instances, to omit them altogether.

† Craiginnan is the hill which rises immediatly behind Dollar, and is connected by a series of conical hills with the romantic and precipitous Craig Rossie, which rises to the westward of the village of Dunning in Perthshire.

decomposing steatite. The beds of the greenstone itself are also separated by thin seams of this steatite, which contains considerable quantity of iron pyrites. The gradation * from the rock in which the hornblende predominates to that in which a beautiful flesh-red felspar prevails, is marked in a series of six alternating portions of greenstone and clinkstone, which commence at the above-named section, and may be traced in the face of Bencleugh beyond Alva.

It is worth recording, that a bed of greenstone occurs in a coarse conglomerated rock in the hill of Balcanquhal †. It is of small extent, and may be seen in all sides except at its base. There can therefore be no doubt of its relations to the rock in which it is imbedded, from the characters of which it may be fairly presumed, that it does not owe its existence to volcanic agency ‡.

The characters of the greenstone, are those which commonly occur, except in the higher alternating beds, where they assume those of the

---

* It is a curious fact, that all the red varieties of rock that I have observed in the Ochils, occur at the highest points. It is difficult to form even a conjecture as to the cause of this.

† About three miles from Kinross, to the north of the road between that place and Cupar.

‡ If this bed of greenstone were spouted up from the centre of the earth, the intensely hot fluid mass must have acted on the bed through which it flowed. But of this action there is no evidence.

rock, which Mr Jameson calls Sienitic Greenstone. It is occasionally porphyritic, containing fine and indistinct crystals of rutilite.

### X. *Claystone-Porphyry.*

On the south side of the Abernethy hills, a bed of flesh-red claystone porphyry, with crystals of glassy felspar, is above the clinkstone, and some varieties of greenstone, but its relations are wholly undefined.

### XI. *Felspar-Porphyry*

Forms the caps of the highest hills which lie between Dunning and Dunblane. It is a compact flesh-red felspar, containing crystals of white calcareous * spar. In the course of the streamlet which runs past Castle Campbell, it alternates with greenstone. It occurs in decomposed fragments on the summits of Craiginnan, King's Seat, Bencleugh, and Dalmyatt. These decomposed fragments have a vesicular appearance, from a very obvious cause, (the rapid decomposition of the included crystals). This appearance would no doubt be ascribed to



* This appears to be intimately connected with the sienitic greenstone. Some beautiful masses of this rock are to be seen higher than the greenstone, at Craig Rossie, near to Dunning.

volcanic agency, by those whose zeal for hypothesis outstrips their love of accuracy.

Only the lower portions of this rock contain crystals of hornblende, which give way at the higher points to those of calcareous spar.

## XII. *Compact Felspar.*

Very beautiful brick-red and flesh-red compact felspar, possessing all the usual characters, forms the caps of some of the smaller hills of the southern chain of the Ochils, which extends from the neighbourhood of Dollar, to the banks of the Eden. Near Cupar, it occurs so abundantly, as to be the sole material for repairing the roads. It appears to be the newest member of the series, and to correspond both in its individual characters, and in its geognostic relations with the felspar of the Pentland Hills, where it was first noticed forming distinct masses by Professor Jameson. At the summit of Lucklaw, this felspar passes into hornstone. A solitary bed of it is to be found in the alternating series of sandstone, claystone, and tuff, in Wormit Bay.

## Veins.

Having thus briefly noticed the prevailing rocks, I shall now mention the veins traversing these

rocks, in the order of the strata in which they occur. Contemporaneous veins are not uncommon in the clinkstone and greenstone; but true veins are more rare. The following is the order of the latter:

1. Calcareous spar. 2. Steatite.
3. Heavy-spar.
4. Iron. 5. Cobalt. 6. Silver.
7. Copper. 8. Lead.

### *Calcareous Spar.*

Highly crystallised varieties of the calcareous spar traverse the clinkstone, near Woodhaven, and the claystone near to the Rumbling Bridge. It has a greenish tint, and all the usual characters. The dip and direction not easily determined. The thickness from half an inch to two inches.

### *Steatite.*

Veins of this steatite, varying from one to two inches, divide the strata of the clinkstone, and of the greenstone, at the section above Westertoun and Alva. They occasionally contain iron-pyrites crystallised, in cubes, in considerable quantities.

### *Heavy-Spar.*

Straight lamellar heavy-spar is the veinstone of the mine behind Castle Campbell, of those of Alva Hill, and Airthry Hill, in all of which it traverses the newer varieties of the clinkstone, which approach to felspar through the greenstone. They are four or six feet wide, with their outgoings to the south. Dip near 45° to the north-east; but from the falling in of the roofs and other accidents, it was impossible for me to ascertain any particulars respecting them. It is in these veins of heavy-spar, that the cobalt, silver, copper, and lead, have been deposited. Of the two first of these, I could discover no trace; though there is no doubt that both have been obtained in considerable quantity. The fullest account I have been able to meet with of the silver mines, is that contained in Sir John Sinclair's Statistical Account of Scotland, under the head Alva. Of the cobalt, I have seen no published account. It appears, that both these metals were found in the Alva Hill.

Copper and lead are still to be found both in the mine behind Castle Campbell, and in the mines of Alva. But the specimens (which alone I could procure) at the entrance, are so much acted upon by the weather, that I cannot venture to at-

Its roof, or immediate covering in the stratification, and its floor, or what it rests upon, consist both of clay, with which the coal is much mixed, and of course much contaminated.

The general dip of the whole of the strata in the Campsie Hills district, is to the south-east, varying in different places from an angle of sixteen, to one of thirty degrees.

The following is a Table of the Strata as they occur in the eastern part of the district at Murray's Hall, where the trap displays a perpendicular face, of from seventy to eighty feet; and a Table of the Strata near its western extremity, in the vicinity of the village of Campsie, where the coal is found in its greatest thickness.

## II. *A Geological Account of the Southern District of Stirlingshire, commonly called the Campsie Hills, with a few remarks relative to the two prevailing Theories as to Geology, and some examples given illustrative of these remarks.*

By Lieutenant-Colonel Imrie, F. R. S. Edin.

*(Read 1st February 1812.)*

The tract of country to be here described, is at present denominated the Campsie Hills, and was formerly called Lennox. It is almost entirely situated in Stirlingshire, and forms the southern district of that county. In the west, it commences between the town of Dunbarton and the village of Drymen, and stretches from thence towards the east and north-east; in which direction, it is about twenty-two miles in length, but in its breadth it is variable. About the centre of the district, it is nearly ten miles broad, and this breadth diminishes towards its western and eastern extremi-

ties. It is bounded upon the south by Dunbartonshire; and, on the north, by a lowly undulated tract of ground, stretching from the village of Drymen to the town of Stirling, which tract forms the southern part of the river district of the Forth.

The general surface of the Campsie district, may, in the strictest language, be denominated highly undulated. Its surface majestically portrays the Bay of Biscay after a western gale, and its high undulations follow each other in regular succession. These undulations are of great length from south to north, and, nearly in that direction, the most of them stretch from side to side of the district. The general contour of these lengthened hills, individually, is somewhat uncommon, although not peculiar to that part of the country. Each hill has a considerable degree of curvature, the convex side of which, is uniformly presented to the west: the central part of that curve, forms the highest point of their elevation, and they gradually slope towards the extremities of the segments which their curvatures form. Upon their eastern sides, they rise with an equal acclivity of from twenty to thirty degrees; the rapidity of which, in some degree, diminishes as it approaches the summits, where they are somewhat round-backed. Their central or highest points seldom or ever exceed an elevation of from twelve to fifteen hundred feet above the level of the sea; at which height, their western faces very generally

become abrupt and broken, and continue to be precipitous for a considerable depth under the lip of the hill; but these broken and abrupt faces seldom shew more of the stratification than that of the trap, which in such situations evidently points out its strong tendency towards columnar form. At the bases of these precipices, a long and rapid slope of debris succeeds, which are frequently covered by vegetation. The troughs or hollows between the undulations, generally form narrow dales or glens, but some few of them have a sufficient breadth to entitle them to the denomination of valleys. The most extended of these, are the vales of Campsie, and of Fintry.

Such is the general contour or outline of the surface of this district, with only one or two exceptions; the most prominent of which, is a hill of somewhat conic appearance, called *Meikle Ben.* This hill is situated a little to the south of the road which leads from Fintry to the vale of Campsie. It towers above all the other heights of the district, and rises superior to them at least 300 feet. As far as the interior of this hill can be examined, it is found to be composed of the same species of trap which is so generally the incumbent stratūm of the Campsie district. From the base of this hill, issue the rivers of Carron, and of Endrick; the first of these takes an eastern direction, and empties itself into the Frith of Forth; the second takes a western direction, and flows into Lochlomond. This circumstance of the

two rivers rising nearly at the same point, and immediately flowing in directions diametrically opposite to each other, sufficiently ascertains that this hill of Meikle Ben forms the saddle of this part of the country.

I shall now proceed to describe the interior structure and composition of this hilly district.

As far as this tract of country has been dipped into, the geological materials of which it is formed are as follow: A surface of vegetable soil,—trap,—sandstone,—limestone,—shale or slate-clay,—blue clays of various tints and of various consistences,—bituminous shales,—clay iron-ores, some of which are thinly stratified, and others are imbedded in the shale in lenticular forms,—coal,—and clay-marl; all of which materials, have been arranged by nature in the order in which they are here placed, from the surface-soil downwards.

The *vegetable surface-soil* of this district, is but thinly scattered over the face of its hills: it consists mostly of an argillaceous matter of a light brown colour, much mixed with the small debris of the trap on which it generally rests, and from the decomposition of which it has evidently originated. The quantity of iron in this soil is considerable, and it owes its colour to an oxide of that metal.

The rock which occurs immediately under the surface-soil, is *trap*, which generally, in this district, is of great thickness, and, in the broken

western faces of the hills, it frequently shews this thickness in sections of from 70 to 100 feet, perfectly perpendicular to the horizon. These faces almost always display an arrangement of polygonal columnar forms, which generally rest upon sandstone: But, in some instances, I have observed this great body of trap divided into two beds of nearly equal thickness, the upper bed shewing distinctly its strong tendency towards taking columnar form; but the under bed, upon which these columns stand, being perfectly amorphous, and shewing no tendency to any form whatever. The columnar forms of the trap in the upper bed, although clearly apparent, are very irregular in their constructions, as to size, sides, and angles; no symmetrical similitude is to be observed among them. They have in general from three to six sides, and are of various diameters, from one to seven feet. Their heights, at Murray's Hall, may be traced, in the front of the precipice, from seventy to eighty feet, and their positions are in general vertical. Some of these columns appear to be jointed, but these apparent joints have no regularity in position or direction; and these appearances seem only produced by accidental cracks which cross some of the columns. The amorphous part of the trap, which sometimes is interposed between the columnar trap and the sandstone, is of the same composition as the upper bed, but their component parts differ in their proportional quantities; that is to say, that the under

bed contains a much greater proportion of iron than the upper does, and their quantities of hornblende and felspar also vary. When both of those beds are equally exposed to the external air, the under one is seen to be much more under the influence of decomposition than the upper one.

This rock is the Flœtz-Trap of Werner; its composition consists of hornblende, compact felspar, a few scales of mica, some minute portions of iron-pyrites, with an admixture of ferruginous particles, which, in the columnar part of the rock, seem to be but slightly oxidised.

The *sandstone* of this district forms a very general part of its geological composition. The small quantity of cement, which is one of its component parts, and is the cause of the cohesion among its particles, is a white clay, which entitles it to the denomination of an Argillaceous sandstone. The thickness of the various beds of this rock here, is very unequal, and the layers of its strata are from three to eight feet thick. The upper stratum of this sandstone, upon which the trap rests, is generally of a whitish-grey colour; but, in passing downwards, it becomes in colour a whitish-yellow, which at last tints down to a yellowish-brown, from a slight admixture of iron in its cement. Its granulations of quartz are small, and its texture is rather compact; but the adhesion among its particles, is in general by no means strong.

*Limestone* also forms here a very general part of geological composition: it is found in almost every part of this district, and occurs in separate beds, which are, as to depth, considerably removed from each other. In the eastern part of the district, this limestone is found in two separate beds; the upper one of which varies in thickness from two to four feet, and is one hundred and seven feet under the surface. The second bed has generally a thickness of six feet, and is one hundred and twenty-five feet under the surface. This last bed is in many places extensively wrought by mining; it produces lime of an excellent quality. The limestones of these two beds, are both of a dark bluish-grey colour; they are of a glimmering lustre, and are opake. Their fractures are small splintery, and are somewhat brittle; they are nearly semihard inclining towards soft. Small portions of iron-pyrites and minute petrifactions of entrochi, are imbedded and thinly scattered in their masses. Both of these beds are much intersected by narrow veins of bluish-white calcareous spar.

The *clays* of this district are generally of a dark blue colour, and remarkably tenacious. The shales or slaty-clays are from a dark blue colour to almost that of black; in some places, this shale admits into its composition a small proportion of bitumen and particles of coal-glance. They are of various indurations from very soft to hard. The intervening strata between the two beds of

limestone consist of sandstone, clay, shale, &c.; for the natural position of all of which, see the list of strata and the section.

*Iron-ore* is plentifully produced in many parts of this district, and it consists of two kinds. The first is found in thin strata, the beds of which are from four to fourteen inches thick; and these beds are separated from each other by layers of blue clay strongly tenacious. The second kind is the lenticular shaped or ball-formed iron-ore, which is found imbedded in blue clay, and also in shale, generally in the near vicinity of coal. Upon the southern confines of this district, in the parish and vale of Kilsyth, I examined with much attention one of the mines which is remarkably productive of this lenticular formed ore. I there found the balls imbedded in a soft shale, and regularly arranged in strata; they rest upon one of their flattened sides, and their distribution is nearly lineal; but in these lines, they are seldom imbedded so near to each other as to come in contact. The balls of each line were generally of the same size. In the deepest strata, the largest balls are found, and the smaller-sized ones are found in higher strata. The largest which I measured, somewhat exceeded a foot in diameter, and they diminish from this size down to a quarter of an inch.

The interior arrangement of these lenticular forms, is so well known, that no description is here necessary; they have, however, afforded a field for considerable discussion, and proofs to aid

theory have been endeavoured to be drawn from their interior appearances. The metal produced from this lenticular ore, is far superior, both in quantity and in quality, to that which is extracted from the ore that is found thinly stratified.

*Coal* is very generally found around the whole of the border of this district, excepting upon its northern side; and I have little doubt, but that the whole of the Campsie Hills are incumbent upon a coal-field. This, however, remains to be proved, as no coal has as yet been attempted to be found in the central part of the district, where the vast thickness of the trap stratum proves a bar to making trials of that kind at a moderate expence. Towards the western border, in the parish of Campsie, and at the eastern extremity of the district, in the parish of Larbert, coal has been long and extensively wrought. Coal has also been long wrought upon its southern basis, where its hills dip into the vale of Kilsyth. The beds and seams of coal that have been already wrought, are of various thicknesses in various situations; but none of them exceed four feet. Their depth under the surface-soil, varies from seven to twenty-two fathoms. This coal is by no means of the best quality: it is very generally found to contain a considerable quantity of sulphur, and its bituminous ingredient is far from being ample. In burning, it emits a disagreeable smell, and leaves a very large proportion of ashes.

Its roof, or immediate covering in the stratification, and its floor, or what it rests upon, consist both of clay, with which the coal is much mixed, and of course much contaminated.

The general dip of the whole of the strata in the Campsie Hills district, is to the south-east, varying in different places from an angle of sixteen, to one of thirty degrees.

The following is a Table of the Strata as they occur in the eastern part of the district at Murray's Hall, where the trap displays a perpendicular face, of from seventy to eighty feet; and a Table of the Strata near its western extremity, in the vicinity of the village of Campsie, where the coal is found in its greatest thickness.

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In the above section at Murray's Hall, the coal has not yet been found, and by the other taken near to the village of Campsie, the trap does not exist; but this last-mentioned section was taken in one of the vales, in which situations, the trap sometimes disappears, and these disappearances seem, in a great measure, to have been effected by the attrition of rock masses, set in motion by heavy and rapid currents of water.

In all situations of this district, where the trap has disappeared, the vegetable or surface soil rests upon a strongly tenacious blue clay, much mixed with water-worn stones, and this blue clay rests upon sandstone. Among the water-worn stones imbedded in the clay, I seldom found specimens of the native rocks of the district; those which I examined, consisted mostly of rocks generally deemed of the oldest formations, such as quartz, porphyries, granites, &c.; the native beds of which, are far distant to the north and west of that part of the country.

I have here mentioned above, that the disappearance of the trap in some of the glens and narrow vales, seems to have been produced by the effects of the attrition of heavy bodies set in motion by a great force of water in rapid movement. But this hypothesis requires explanation, and an exposition of the phenomena upon which it rests. These, I shall here endeavour to describe, as they appeared in some parts of this district.

In some of the glens and narrow vales, where the trap had not entirely disappeared, I perceived upon its surface strong indications and marks of attrition. In some places the surface of the trap was smooth, and had evidently received a considerable degree of polish; and this polish is almost always seen marked by long lineal scratches. In other places, there appeared narrow grooves, apparently formed by the rapid movement of large masses of rock having been swept along its surface; and I remarked, that these striæ or scratches, were very generally, in a direction from west to east, excepting where inequalities of the surface, and sudden turns in vales had partially influenced the course of the current. In the eastern part of the district, there occurs a small elevated plain slightly undulated. Here the surface of the trap, in some places, had lost its covering of soil, and was left bare for inspection. Upon this plain, I again detected some of these scratches, which were, in this situation, generally in a direction from west to east, sometimes deviating a little towards the south-west and north-east, and sometimes towards the north-west and south-east; but in taking the average or medium of these directions, their general and true course seemed to me to be from west to east. Upon the surface there were scattered immense masses of the trap, which, from their apparent weight, seemed perfectly capable

of forming these scratches and grooves above described, had they been put in motion and impelled along the surface. Upon examining some of these huge masses, I found their surfaces scratched and worn in such a way as to prove sufficiently indicative to me, that they had been long subjected to attrition in water; and I also observed, that many of them presented their principal or most projecting angle towards the west, and sometimes towards the north-west, which, according to my opinion, strongly implies the direction of the current which left them in the position in which they now rest. It is not the object of this paper to dip into the causes of this phenomenon; but that such currents as were capable of the effects which I have endeavoured to describe, have flowed over the surface of our globe, is to me, clearly evident, and these scratches and grooves here mentioned, are some of the minor, but clear proofs of its action. To examine upon the great and true scale the proofs of these currents having existed, we must, in Scotland, enter among the Grampians; and we will there see, that the mountains of that range *very generally* present their most bluff and abrupt sides towards the west, and the north-west points, and tail and taper away towards the east and south-east.

The above observations relative to this subject, may to some appear trivial and unimportant; but

I have here given them, as they relate to a phenomenon, which, I think, merits some attention, especially when the various changes that have taken place upon the crust of our globe, are taken into consideration.

By the description here given of the general stratification of the Campsie Hills district, it will be perceived, that it presents nothing peculiar or very remarkable among its various strata, and is in a great degree similar in its formation to most of the coal-fields in Scotland. I may, however, perhaps be here permitted to except one dissimilarity,—which is the immense bed of trap that is so generally the superincumbent stratum of this portion of the country. From the general configuration of this trap into columnar forms, it will be deemed by some geologists to be of volcanic origin, or that these forms have been produced by the effects of internal heat. In consequence of the writer of this memoir having examined much of Mount Etna from base to summit, and having been frequently upon Vesuvius, as also having visited some of the Lipari Islands, he may perhaps be allowed to have gained some knowledge regarding the apparent effects of heat upon fossil bodies; and, assuming upon this knowledge gained by his frequent visits to volcanic regions, he proposes to venture here some opinions upon this controverted subject; and, in doing so, he must commence by

stating, that, in the district above described, he could perceive no effects either as to matter or form, that might not have been produced by atmospheric action alone; nor could he perceive any appearances in the various strata that occur under the trap, that indicated in any degree, interior heat having ever acted upon them. It is well known, that with regard to geology, there are two systems very different from each other, and by the tenets of these systems, they are widely separated. The adopters of these systems are in general keenly bent towards their support, and fiercely argue upon the propriety of their different creeds.

One class of those philosophers, hold, that the polygonal forms which have been here described as belonging to the Campsie Hills district, are of aqueous origin; and some of this class, even go so far as to say, that the columnar forms found so frequently in the vicinity of volcanic regions, have not assumed that form in consequence of volcanic fire, but that such columns have been only detached from their interior native rocks by the violence of volcanic shocks, and have been ejected in their native state unchanged by volcanic fire.

The other class of philosophers, hold these forms to have been produced by the agency of volcanic fire, or from internal heat proceeding

from some other cause. This last-mentioned class, do not, however, (as is generally thought,) hold all the formations of the crust of our globe, of which we can claim acquaintance, to be of igneous origin : they admit clearly that some of the strata have been formed by a deposition from water; but for the *consolidation* of these strata so formed, they think it necessary to call in the aid of internal heat, and hold these polygonal forms to have been produced in consequence of its effects. Such, upon this point, is nearly the general outline of the difference of opinion subsisting between these two parties. But it ought to be remembered, that nature frequently produces the same effects by very different means, and that the columnar configurations are formed not only in the *moist* but also in the *dry* way; which can be here easily exemplified. The aqueous origin of these forms, may be observed upon any extended surface of clay or of mud, which has been the deposite of water, and where evaporation has taken place. In such situations, when evaporation has taken place to a considerable degree of dryness, the deposited soil gradually shrinks, cracks in various directions, and takes polygonal forms. If the soil in such situations is shallow, the *tabular* form is exhibited; but if the soil is of any considerable thickness, the *columnar* form appears. Beautiful displays of these forms on a small scale, may fre-

quently be seen in the operation of starch-drying, and in some of the preparations for pottery.

Upon the large scale, this operation of nature is to be seen to the greatest advantage in warm climates, where evaporation is strong and rapid; one example of which, I shall here beg leave to describe, it having struck me as being a remarkably good and explanatory specimen of this phenomenon. The notes which I took upon the spot where this specimen occurred, are now before me.

In the Mediterranean, on the coast of Africa, this example fell under my observation some years ago. In the near vicinity of a considerable rivulet, deeply imbedded in a soft soil, there had existed a piece of water of considerable expanse, on a level of about twenty feet above the stream of this rivulet; one of the windings of this stream had undermined, and had carried off a great part of a rising ground that had served to imbank upon one side this former lake; which bank, when broken down, had given drainage to it, and had laid open its deposited soil to a considerable depth. Upon this broken down side, the soil of the former lake displayed a beautiful arrangement of columnar forms. These were in length about eighteen feet, and were from a foot and a half to three feet in diameter, but, as to their magnitudes and forms, they varied much from each

other; although, however, there was no very striking similarity to be observed among them, they were all angular, and their forms generally consisted of four, five, and six sides. They were perfectly vertical in position, and their forms were to be traced nearly down to the stream which had invaded their situation. Upon examining the surface which the lake had formerly covered, I found it perfectly level, and divided into polygonal forms by fissures and cracks, stretching out in all directions, which, by intersection, formed the columns here described; on the tops of which, I stepped from column to column, as upon a Giant's Causeway. Some of the cracks and fissures had been here filled up with dust of a blackish-brown colour, which gave some parts of this surface the appearance of mosaic work. The majority of the tops of the columns were certainly very irregular as to form, yet there were some among them that could be perceived approaching very nearly to regularity in sides and angles: two of these particularly attracted my attention, and which I found almost bore the test of measurement. These two were pentagons; the one was two feet, and the other a foot and a half in diameter. The muddy clay of which the whole of these columns were composed, was almost of an impalpable grain, and was of a reddish-brown colour; it had gained a considerable induration in

the mass, but could be easily scratched by the nail. This example is drawn from classic ground: I discovered it in the vicinity of ancient Carthage, where debris now only mark the former site of that great and important city.

Those geologists, who, upon the other hand, assert, that columnar forms are not produced by volcanic operation, must surely have never visited a real volcanic region. Proofs of this form having taken place in consequence of volcanic agency, are to be seen around the sites of almost every volcano where lava has been erupted. I shall, however, not now take up the time of this Society longer, than by giving one of the many examples that I could bring forward in proof of this assertion being well founded; and this example I shall draw from a subject which cannot bear a dispute as to its being of volcanic origin; and which, according to my opinion, will alone prove decisive.

The Eolean or Lipari Islands, are clearly ascertained to be of volcanic origin; the greater part of them have been visited by men of science, who, from their geological knowledge, were perfectly adequate to ascertain of what materials they are formed, and to describe those materials scientifically. Felicuda, is one of the most western of this group of islands. It is generally reckoned from eight to nine miles in circum-

ference, and is entirely formed of lava and other volcanic productions. In the interior of this island, there is a mountain of considerable height, upon the summit of which may be traced the principal crater of this now extinguished volcano.

The form of this crater is a regular cone inverted, and its lip nearly measures half a mile in circumference. From this mouth, and from its sides, have flowed many streams of lava, some of which may still be traced in various directions. Where these streams had flowed over planes slightly inclined, their surfaces in general continued to be tolerably smooth; but where descents were more rapid, there in many places, the surface-crust of the lava had burst, and in such a situation, it presented a broken, rough, and rugged appearance.

One of these streams of lava, I was enabled to trace until it arrived at the verge of the island, where it had dropt into the sea over a lava rock nearly perpendicular, and which rose from the level of the water to a height of not less than from sixty to seventy feet. The lava here, even after it had passed over the verge of this precipitous declivity, still retained for a short distance a considerable degree of smoothness, but which was soon broken in upon by narrow longitudinal furrows appearing upon its surface. These lines at

first, only slightly marked their directions; but, as they descended, they became deeper and deeper, until their interstices began to assume an approach towards form, and near to the water, these forms were seen perfectly columnar. At this place, the columnar forms thus produced, by the congelation and shrinking of the lava, had generally three, and some of them four sides; one of which sides, always continued attached to the amorphous mass of lava from which the column had shrunk. Upon some other parts of the shores of this island, I observed these forms arrested in various stages towards complete columnar shape. In some of those situations, the striæ or lines had only appeared, in others, form was slightly indicated; in some places they were seen half formed, and in others, their formation was complete.

Upon the sides of the island, where these forms occurred overhanging the sea, I observed that they seldom or ever arrived at a full completion of their figures, until they approached nearly the surface of the water, and they continued perfect in form as far under the surface of the water as I could distinguish them with my eye. The columnar forms which I saw upon this island, were in general four-sided, but there also occurs among them many of three, and some of five sides; but those last of pentagonal form, are rare. The general run of their diameters seldom exceed two feet.

In one part of this island, I discovered a great accumulation of fragments of obsidian and of pumice; but these are two substances, which some geologists will not admit to be of igneous origin. With regard to this point in dispute, I must here repeat what I have already observed in another part of this memoir, that those who hold obsidian and pumice not to be of igneous origin, most certainly can never have trod true volcanic ground. Proofs of these two substances being of igneous origin, are to be seen upon Etna, Vesuvius, and upon some of the Lipari Islands; and those proofs which I have there seen, appeared to me so evident, that their origin could admit of no dispute. One or two examples of these proofs, I shall here beg leave to give, by copying some of the notes which I took while on the Island of Felicuda. Near the centre of the island, somewhat to the south-east of the principal mountain which I have had already occasion to mention, I discovered the remains of a crater upon an insulated hill, which I found entirely formed of different coatings of lava of various thicknesses. In two different currents of the lava proceeding from the broken crater of this hill, I observed obsidian which had been in flow with the lava, and now formed part of its congealed stream. This obsidian when in mass, appeared almost black and opake; but, at the edges of its beautiful conchoidal fracture, it was in some degree trans-

lucent, and there shewed a muddy-brown colour. In some parts of this obsidian, it is seen deviating from its brilliancy, and from its compact vitreous texture, and is evidently seen passing into a granular lava; but the marks of this gradual transition are soon lost, and the lava into which the obsidian had passed, is then not to be distinguished in colour, in fracture, nor in texture, from the general lava of the other parts of the stream. Where this obsidian appears in mass, and in a state of perfect glass, it is very near to where it has been first ejected from the side of the crater, and in a situation where it must have undergone a rapid cooling. In some parts of these congealed streams, I could trace a transition of the obsidian into pumice. In those places, the obsidian was seen to contain scattered air-globules, which were almost always lengthened in the direction of the stream. These globules gradually augmented in number until the whole of the substance became a light, fragile and frothy pumice.

At the place where I discovered the great accumulation of obsidian and pumice, mentioned above, I saw and obtained many specimens of all the transitions here described. In the various streams of lava which had flowed from the principal and central crater of this island, I found many indications of pumice, but none of obsidian.

The above observations relative to some of the facts and tenets connected with the two theories in geology, which are so much at variance with each other, are certainly in a great degree foreign to the greater part of the subject which this paper was originally intended to embrace. But having, in the first part of this memoir, carefully avoided mixing *description* with *theory*, and as a phenomenon occurs in the district described, which is one of the controverted points, I have presumed to lay before this Society a few of the facts which relate to both of the theories, and which consist of those alone which have fallen under my own observations when visiting various parts of the globe; but, in doing so, I am afraid, that according to the opinion of some, and perhaps according to my own, I have been led into a digression, which I have made too multifarious, and considerably too long; for which I here beg leave to apologize.

I, however, cannot here refrain from adding one more observation relative to an extreme bad effect which a violent support of theory in geology leads to, and which I am certain, must have been observed and regretted by all impartial geologists. Where the too keen and extravagant support of theory has crept in, and where prejudice has taken root, we must bid adieu to all candid geological description. Not that I here mean to allege, that all describers of geological scenery, un-

der these influences, would intentionally mislead; but many of them stray into error without they themselves being aware of their giving false description. Their minds are warped without their knowing it; and their jaundiced eyes see all objects around them yellow, and they describe accordingly. Reasoning and argument may then be dropt; as the strongly prejudiced mind is not to be convinced, even by a clear demonstration of truth.

## *Explanation of Plate* I. *giving a view of the Strata at Murray's Hall, Campsie Hills.*

| No. of the strata. | Colour. | Feet thick |
|---|---|---|
| 1. Surface soil. | | 2 |
| 2. Trap, columnar. | Lead-grey. | 60 |
| 3. Trap, amorphous. | Rusty greyish-brown. | 16 |
| 4. A narrow line of trap much decomposed, | Ochry brown. | 2 |
| 5. Amorphous trap, very compact. | Dark blackish-grey. | 3 |
| 6. Sandstone. | Light greyish-white. | 3 |
| 7. A narrow strip of slate-clay. | Greenish-grey. | |
| 8. Sandstone. | Pale ash-grey. | 8 |
| 9. Slate-clay. | Common lead-grey. | 6 |
| 10. Limestone. | Bluish-black. | 3 |
| 11. Slate-clay, mixed with glance-coal. | Greyish-black and rusty-orange. | 4 |
| 12. Sandstone. | Pale yellow. | 13 |
| 13. Slate-clay, containing narrow lines of sandstone. | Blackish-grey with bluish-grey lines. | 8 |
| 14. Slate-clay. | Blackish-grey. | 17 |
| 15. Limestone, containing entrochi and specks of pyrites. | Bluish-black. | 6 |
| 16. Bituminous shale passing into slate-clay. | Blackish-grey, with a tint of green in it. | 6 |
| 17. Bituminous shale, containing calcareous matter. The thickness of this stratum is not yet ascertained. | Blackish lead-grey. | |

No. 18. is the entrance to the mine by which the limestone No. 15. is wrought.

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## III. *Chemical Analysis of a Specimen of Magnetic Iron-Ore from Greenland.*

By Thomas Thomson, M. D. F. R. S. L. & E.

(*Read 9th March* 1811.)

As iron is scattered over the surface of the earth in greater profusion than any other metal, and as it is very easily acted upon and altered by the action of the air, of water, and of a variety of other agents, we need not be surprised that the number of its ores is very considerable. It is from these ores that the metal is extracted; and it has been observed, that the quality of the iron obtained, very much depends upon the nature of the ore which has been employed in the manufacture. Some varieties of iron are much brittler, much weaker, much tougher, much more ductile, &c. than others. These differences undoubtedly depend upon the foreign substances which happen

to exist in the iron-ores, and which the imperfect processes of the manufacturers do not enable them to separate. Hence the analysis of the ores of iron comes to be an object of very great importance; as it is the only method of acquiring a knowledge of the nature of the foreign substances which alter the nature of iron. Were they once accurately known, it might be possible to vary the processes of the manufacturers, so as to enable them to get rid of these foreign substances altogether, and thus make all iron of exactly the same quality: or it might be possible to substitute those which are least injurious for those which are most injurious, or, by introducing at once two foreign substances of opposite natures, to neutralize the effect of both.

Magnetic iron, which constitutes the subject of this paper, is one of the most abundant and important of all the iron-ores. It has been usually conceived to consist of pure oxides of iron, and to this purity, the goodness of the iron obtained from it has been ascribed.

The only chemical experiments on this ore, with which I am acquainted, were made by Bucholz *. He ascertained the action of muriatic and sulphuric acids upon it, and concluded from his experiments, that it was a mixture of black and red

* Gehlen's Journal, 2d series, vol. iii. p. 106.

oxides of iron, with a little siliceous matter, in the form of grains of quartz.

The specimen on which the following experiments were made, was found in a Danish vessel which had been brought as a prize to Leith. A collection of minerals was found on board this vessel, which, from the abundance of cryolite that it contained, was supposed to have been made in Greenland. This collection was purchased by Mr Thomas Allan and Colonel Imrie, and is remarkable for containing two new species of minerals, to which the names of Allanite and Sodalite have been given.

The appearance of common magnetic ironstone, is so well known, that any description of it would be superfluous. The specimen examined, was massive; of the specific gravity 4.7619; and had a variety of phosphate of lime adhering to one of its sides.

Sulphuric acid has but little action on this ore, though, by the assistance of heat, an imperfect solution may be produced. With muriatic acid, it effervesces very slightly when previously reduced to a fine powder; and by long digestion on a sand bath, a complete solution may be obtained, with the exception of a white powder, which amounts only to a small quantity.

If the white powder remaining undissolved be digested for several days in muriatic acid, the liquid becomes milky, and passes in that state

through the filter, so that the milky matter cannot be separated. But by spontaneous evaporation, a small quantity of whitish matter was procured; which, after being heated to redness, became insoluble, though it gave out a little iron when digested in muriatic acid. It was heated to redness with four times its weight of carbonate of potash. The mass was then digested in water. By this means, a white powder was obtained. This white powder dissolved in muriatic acid. The solution was yellow, and, when treated with reagents, exhibited the following appearances:

1. With infusion of galls, a reddish brown precipitate fell.

2. Prussiate of potash. A blue precipitate, which became white when a little ammonia was added.

3. Hydrosulphuret of ammonia. A dark green precipitate in flocks.

4. Ammonia. } A white flocky precipitate.
5. Carbonate of soda. }

6. Phosphate of soda. } A white flocky precipitate.
7. Arseniate of potash. }

8. Oxalate of ammonia. } No change.
9. Tartrate of potash. }

From these experiments it follows, that the substance was white oxide of titanium, not quite free from iron.

After all the titanium had been separated from the insoluble part of the ore, there still remained a small portion of white matter. It was fused with potash,—softened with water,—neutralized with muriatic acid, and then evaporated nearly to dryness. It assumed the form of an insoluble jelly. Hence this insoluble portion was silica, not, however, quite free from iron, for it was slightly coloured.

Such was the process followed in the analysis, and such the substances obtained: 100 grains of the ore being treated in this manner, yielded 126.5 grains of red oxide of iron, 4.2 grains of white oxide of titanium, and 2.4 grains of silica.

From the great quantity of red oxide obtained in the present case, it is obvious, that the ore is not a mixture of black and red oxides of iron. Had it consisted of black oxide alone, the quantity of red oxide which it would have yielded, would have been less. The only possible conclusion, is, either that the iron in magnetic iron-ore is a mixture of iron in the metallic state, and of black oxide of iron, or that it is in a state of oxydizement different from any at present known, and in which the metal is combined with less oxygen than in black oxide.

Theory would lead us to conclude, that iron is capable of combining with three different dozes

of oxygen, and of forming three oxides; the composition of each of which, is as follows:

| | Iron. | Oxygen. |
|---|---|---|
| 1. Protoxide, composed of, | 100 + | 15 |
| 2. Deutoxide, - | 100 + | 15 × 2 = 30. |
| 3. Peroxide, - | 100 + | 15 × 3 = 45. |

The second and third of these oxides are known. They are the common black and red oxides of iron. But we remain still unacquainted with the first, which cannot be formed artificially by any known process.

It is by no means an unlikely circumstance, that magnetic iron-ore consists chiefly of this hitherto unknown protoxide. It differs in its properties from black oxide, being more soluble both in sulphuric and muriatic acids, and effervescing slightly during its solution, which is not the case with black oxide. The circumstance also of its being at least occasionally a permanent magnet, ought not to be overlooked. Pure iron possesses this property in a very trifling degree. Mr Hatchett has shewn, that iron may be converted into a magnet, when combined with a minimum of carbon, sulphur or phosphorus, but loses its magnetic virtue entirely when saturated with these substances. It is not unlikely that the analogy may be extended to oxygen likewise. Red oxide of iron is not magnetic at all: black oxide is im-

perfectly so: magnetic iron-ore being so in a great degree, since the substance distinguished by the name of magnet belongs to it, is most probably composed chiefly of protoxide of iron. This, at least, is more likely, than that it should be a mixture of metallic iron, and black oxide of iron, the only other supposition which it is possible to form.

## IV. *Description of a Swordfish found in the Frith of Forth in June* 1811.

By William Elford Leach, Esq; F. L. S.—W. S. &c.

*(Read 27th July* 1811.*)*

### Xiphias *Rondeletii.*

Pl. II. Fig. 1.

X. Corpore sub-scabro, linea laterali nulla; pinnis dorsali analique interruptis.

Long. Corp.—rostro incluso, *Ped.* 8. *unc.* 3.

*Habitat*—in mare Britannico, piscibus minoribus victitans.

*Descr.*—Rostrum compressum, suprà trisulcatum nigrum, infrà sub-carinatum albicans. Oculi sub-argenteo-viridescentes, pupillo pulvinato-albicante-cœruleo-atro. (Membrana branchiostega 5-radiata?) Derma sub-scabra, *dorso* nigricante, *ventre lateribus*que, argenteo-albis. Pinna *pectoralis* argentea, præter marginem anticam suprà quæ nigridine gaudet. Pinna *dorsalis* nigra, interrupta, intervallo exarato. Pinna *analis* cœruleo-nigra interrupta. Linea *lateralis* nulla.

The specimen from which we drew the above description, was taken by some fishermen at Queens-

ferry, and purchased by Mr Macintyre, merchant, who sent it to Edinburgh, where it now is, having been stuffed under the care of Mr Wilson at the College. On dissection, it proved to be a female, and in the stomach the remains of small fish were discovered.

Two other specimens of Xiphias, probably of this species, are recorded by naturalists, as having occurred on the British shores; one by Sir Robert Sibbald; the other by Pennant, as having been washed ashore at Langhearn in Carmarthenshire. The figure of the latter author, I suspect, has been depicted by the fancy of the ignorant artist he employed, to whom the public are also partly indebted for the Trifurcated Hake, an animal lately proved, by the accurate Donovan, never to have existed. The only figure to which we can refer with any confidence, is that given by Rondeletius, who, however, has omitted the posterior anal fin: but it agrees in other points so well, that I have named it, in honour of him as the first discoverer, XIPHIAS *Rondeletii*.

The head was much lacerated: I therefore suspect that part of the branchiostegous membrane has been torn away; this, however, future observations will decide. The superior process of the tail was also incomplete, although there can be little doubt, from what remains, that it was considerably larger than the lower part.

Since the above was written, I have been informed by Mr Bullock, that, some years since, he saw in the Frith of Forth several living specimens of a Xiphias playing in the water; I think he said seven or eight, and he was so near as to be enabled to observe the dorsal fin to be undivided. It is therefore highly probable, that XIPHIAS *gladius* may also be a native of our seas, or perhaps be the other sex of this.

## V. *Some Observations on the Genus* SQUALUS *of Linné, with Descriptions and Outline Figures of two British Species.*

By WILLIAM ELFORD LEACH, Esq; F. L. S.—W. S., &c.

*(Read 18th January 1812.)*

No family of the Amphibia, is in greater confusion, or wrapped in such obscurity, as the SQUALINIDÆ; the characters which distinguish its genera remaining undefined, and the figures of species being so incorrectly given, as never to be quoted without doubt. Much, therefore, remains to be done, and I trust that no zoologist will neglect to describe and figure all that may come under his inspection, and communicate his observations to this Society, through the medium of whose *Transactions* we may hereafter hope to be made acquainted with such species as are found on our coasts. The principal characters which distinguish the species, may be drawn from the nose, neck, and fins, and probably from the colour as well as

shape of these parts: The generic characters from the teeth, the position and form of the mouth, and of the sacral fin. Two genera have been formed from the Linnean genus, viz. SQUATINA and SQUALUS. To these I shall beg permission to add two more, as in the following Table:

*Familia* SQUALINIDÆ.

* *Pinnâ anali*

1. Pinna caudalis lunata, - SQUALUS*.
2. Pinna caudalis irregularis, - GALEUS.

** *Pinnâ anali nullâ.*

3. Os ante oculos situm, - SQUATINA.
4. Os pone oculos situm, - ACANTHIAS.

A more minute division, will, I have little doubt, be hereafter found necessary; but, in our present state of knowledge, I should not consider myself justified in proposing more genera. The sexes of the genera SQUALUS and GALEUS, may be distinguished from the ventral fins being either entire, divided, or furnished with a long process beneath.

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* This genus may be subdivided from the structure of the teeth.

## GALEUS *Mustelus.*

Tab. II. Fig. 3.

G. Dorso plumbeo-nigricante; ventre sub-argenteo albido.

Γαλεος, *Arist. Hist. anim.* vi. c. 10.
GALEUS lævis. *Rond. de pis. mar.* 375. *cum icone.*
MUSTELUS lævis primus. *Will. Icth.* 60.
Smooth *or* unprickly hound. *Raj. Syn. pis.* 22.
SQUALUS mustelus. *Linn. Syst. Nat.* 400.
*Gmel. Syst. Nat.* 1492. 13.
Smooth shark. *Penn. Brit. Zool.* 3. 116. tab. 16.
SQUALUS mustelus, *or* murloch. *Neill, Wern. Trans.* vol. i. p. 549.

LONG. CORP.—Pedes sex.

*Habitat*—in Oceano Europæo.

*Descr.* CAPUT acuminatum sub-rotundatum. PINNÆ *pectorales* suprà nigricans, parte inferiore marginibusque posticis albis. PINNÆ *ventrales* et *anales* albidæ. CAUDA sub-fusco-nigricans, margine inferiore griseo-testaceo aut dilutiore. PINNA *dorsalis atlantalis* * sub-plumbeo-cinerascenti-nigricans, margine postico saturatiore, basi anticè posticèque albido. PINNA *dorsalis sacralis* † cinereo-nigricans.

A specimen of this species was taken by the Newhaven fishermen last June, having been accidentally found entangled in their nets; it was a female, and measured from the inial to the sacral

* Pinna dorsalis antica *auctorum.*

† Pinna dorsalis postica *auctorum.*

extremities, six feet; in the uteri were twenty-six young, agreeing in shape, proportion, and colour with the old one: from one of these, the annexed figure was taken; the description from the adult animal. I am sorry that I neglected to examine the teeth, and cannot but express my regret at such a shameful neglect, for which I can find no excuse. The skin of the old and young was very rough, as is the case with all the other species which have come under my inspection: the term *lævis*, was therefore applied by the older writers, to distinguish it from the piked dogfish of the fishermen, ACANTHIAS *antiquorum*. Mr Pennant says, "The teeth resemble those of a ray, rough and sharp."

### SQUALUS *Selanonus*.

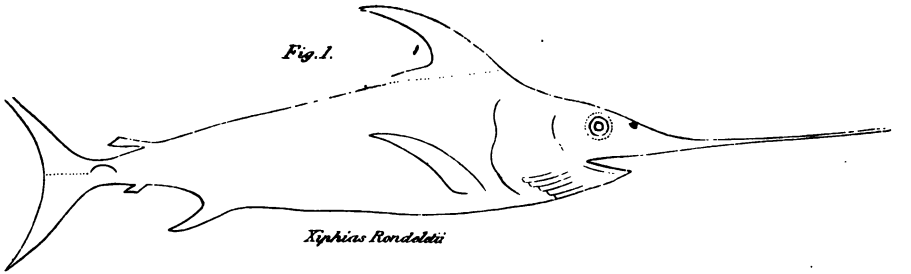
Tab. II. Fig. 2.

Teeth in front, six rows, smooth, with two processes on each side at their base.

SQUALUS *Selanonus*. *Walker MSS.*
Mus. Wern. Soc.

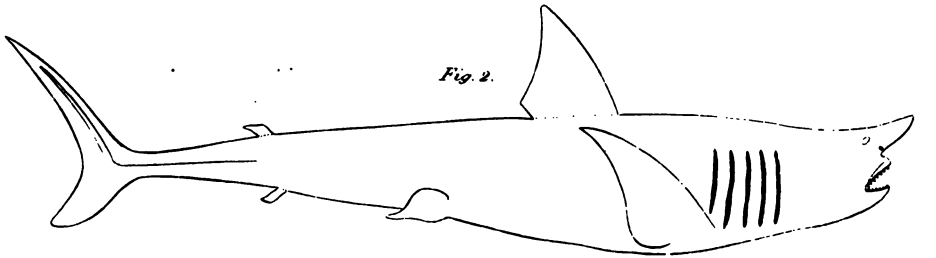
The specimen from which the drawing is made, was taken in Lochfyne, and is figured in the MSS. drawings of the late ingenious Professor of Natural History, Dr Walker, from whose sketch, (through the attention and goodness of Professor Jameson, to whom I stand greatly indebted for the as-

Fig. 1.



Xiphias Rondeletii

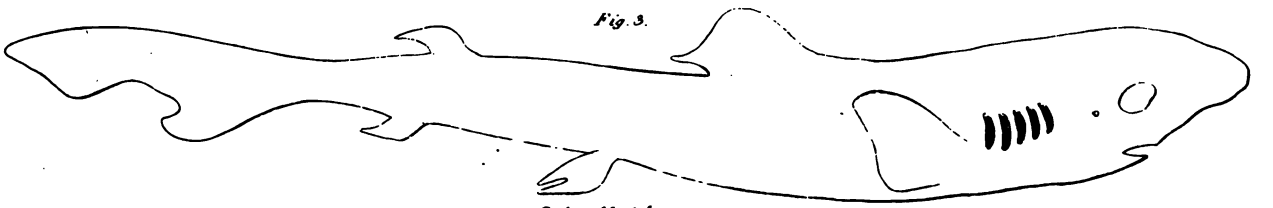
Fig. 2.



Tooth natural size

Squalus Selanonus

Fig. 3.



Galeus Mustelus

sistance he has often rendered me in zoology,) the above name is taken. As the specimen is in a dried state, nothing can be said as to its colour. I may observe, however, that the nostrils are placed on the base of the porrected nose, as may be indistinctly seen in the annexed outline. It may be questioned whether it be an undescribed species. I am of opinion, that it is the Basking Shark of Mr Pennant: it agrees with his description, which was drawn from a recent specimen on the shores of Loch Ranza, Isle of Arran. The figure, it may be argued, is altogether different; but when I inform the Society, that all or most of the figures which disgrace the work of that eminent zoologist, were made by an ignorant artist, and still more stupid engraver, who fashioned the animal to suit their fancy, carefully rounding angles, to give an elegance to their works, the objection will cease. Still, it may be enquired, Is Pennant's basking shark the SQUALUS *maximus* of Linné? or are we to consider that figured by Mr Home in the Philosophical Transactions, as referable to that species? These gentlemen have most clearly described two very distinct species under the same name. La Cepède, in his *Histoire des Poissons*, has figured Pennant's Basking Shark as SQUALUS *maximus* of Linné, calling it SQUALE *très grand.* The length of the specimen of SQUALUS *Selanonus*, which is preserved in the Museum of this University, is about eight feet and a half.

I cannot conclude without observing, that the terms *atlantal* and *sacral*, are applied to the anterior and posterior dorsal fins; although, in this instance, the terms *anterior* and *posterior* would have applied equally well, yet, on other occasions they would be subject to much objection; for the sake of uniformity, therefore, they are used here also. I am happy in being enabled to state, that the anatomical nomenclature of Dr Barclay is adopted by several of the most eminent zoologists in this country, who in future will introduce them into their descriptions, thereby avoiding that ambiguity of language which has rendered nearly useless the valuable works of several older writers.

Since the above was given to the Society, I have been favoured by my worthy friend the Rev. John Fleming, with the jaws of SQUALUS *Selanonus* taken in Zetland, which agrees with that in the Museum of the College.

## VI. *An Essay on Sponges, with Descriptions of all the Species that have been discovered on the Coast of Great Britain.*

By George Montagu, Esq; F. L. S. & M. W. S.

*(Read 7th March 1812.)*

Little has been added to the division of *Zoophyta* as British, since the time of that enlightened zoophytist Mr Ellis, to whom we are greatly indebted, not only for the discovery of numerous species of the several genera that constitute this class of animate beings, but for his critical investigation. By his indefatigable researches, microscopical inspection, and judicious dissection, he clearly demonstrated, that the subjects of this division (which had been considered as extremely ambiguous, from their general appearance bearing so much similitude to plants) are truly of *animal* origin. Many indeed, which appear to possess all

the qualities of marine plants, such as roots *, stem, branches, and vesicles bearing the young *in embryo*, like seeds, (as exemplified in *Sertularia*,) are formed for the support of an animal of a most complicated nature. These coverings, or more imperishable parts of *zoophytal* animals, grow in the same manner, and some perhaps draw in nourishment in a similar way, as *fuci* and *confervæ*. Like shells, however, they are constituent parts of an integral animal, expanding with it according to the laws of nature.

The subjects in *Zoophyta*, as in *Testacea*, when examined in the cabinet only, exhibit that part of the animal which is the least perishable; and of course, that, by which science has been best able to define, and reduce them to system, for the better ascertaining the distinction of the numerous species.

It is not, however, my intention to enter into a general history of the nature of *zoophytes* in this place; nor is it required; since nothing further is necessary for those who demand instruction in this abstruse science, than to peruse the works of our countryman Ellis. There are indeed some of the subjects which belong to this class of beings, that possess so small a share of apparent vitality, and are so indefinite in shape, that even

* Radical tubes, or ramifications resembling roots, by which they are affixed to other bodies.

that great illuminator in this science, could not define them: amongst these, *Alcyonium* and *Spongia* seem to rest nearly where they were left by Ellis. Of the former, if we were to confine the genus to an aggregate of polypes, enclosed within superficial cells, (which appears essential,) then several of the species of *Alcyonium* would be removed, particularly *lyncurium*, *cydonium*, *bursa*, and perhaps some others. In these three, no stellate pores or cells, nor polypes, have ever been observed.

*Bursa* is without doubt a *Conferva*. *Lyncurium* and *cydonium* approach very near to *Spongia;* but these, with two or three others of similar structure, might perhaps be formed into a new genus, if any advantage to science could be gained by it. However, till we are better acquainted with more of this intricate family, I shall arrange two or three of the same structure (which are perhaps new) in the genus *Spongia*, as bearing strong characters of such, according to the Ellisian definition.

The animals of this genus, the most inert and least definable by means of the animal itself, are extremely obscure; consequently it is not sufficient that such anomalous beings be described in half a dozen of words, which is all we have to direct us with respect to many species. In most instances, shape is not to be depended upon; and, as the greater part of the sponges we obtain, are thrown ashore by the sea after storms, few are found

perfect. Those in which we are the least likely to err, are such as are branched, lobated, foliated, or digitated, or possess something like specific characters independent of texture; but, at the same time, texture must be a leading feature in discrimination, for, in the more compact sponges, destitute of ramifications or appendages, and where shape has no uniformity, texture alone must guide our opinion.

Under all the difficulties I have to encounter with respect to synonyma, I am induced to offer an essay on the British species of this intricate genus, for these reasons: 1*st*, Because I possess many that do not appear to have been described; 2*dly*, Because no British naturalist, since Ellis, has exclusively undertaken the subject; and, 3*dly*, Because it may pave the way to greater exertions in this occult science, by stimulating others to reap in the same field, and give their gleanings to the public.

If I fall into error with respect to synonymes, those who have studied the subject will readily excuse it, from their knowledge of the difficulty of avoiding it. If I fail in my endeavours to define all the British species of *Spongia*, I am sure of obtaining two desirable objects;—that of the pleasure and information the study and researches have afforded me; and also that of allowing the scientific to participate with me in the benefit of these researches, which some friends have urged me to publish.

It would appear that Mr Ellis found much difficulty in ascertaining the species of this genus. By him seven only seem to have been described, viz. *coronata, oculata, tomentosa, stuposa, cristata, palmata,* and *botryoides.* In addition to these, Berkenhout has given *dichotoma;* Mr Sowerby, in his British Miscellany, enumerates three others: *pulchella, cancellata,* and *compacta;* and, lastly, we find *infundibuliformis, ventilabrum,* and *compressa,* described as British by Professor Jameson in the first volume of the Memoirs of the Wernerian Society; making together fourteen species.

It will be noticed, that, in the following pages, I have almost twice that number; and of those which possess sufficiently strong specific characters to be defined by the pencil, figures have been given.

With respect to the nature of sponges, there has been considerable difference of opinion; but, in the present era of natural history, it is pretty generally allowed, that they are truly of an animal substance, extremely torpid, and for the most part, if not wholly, destitute of visible motion. With considerable attention to some species taken fresh from the sea, and others that I have examined in the cavities of their native rocks, still immersed in their natural element, not the smallest motion was perceptible, nor were there any appearances of internal action; for such would have produced some

currents or slight agitation in the water, which must have been perceived by the assistance of glasses *. Action, however, is by no means necessary to constitute an animal; for in many instances vitality is known to exist without mobility.

Zoophytes in general are destitute of locomotion; and what action any of them possesses is very limited, being chiefly confined to the multifarious polypi that constitute them. The only genus of *Zoophyta* which is not possessed of polypes, is *Spongia;* and it is to be wished that this character should be continued in contradistinction to *Alcyonium*, which Mr Ellis established as the basis of separation in the two genera.

In the generic characters, Bosc has unfortunately omitted this essential distinction, as he has described both genera to be *polymorphous polypi*, which should imply that *spongia*, as well as *alcyonium*, is constituted by polypes. This is contrary to all experience, and indeed is in direct opposition to fact.

It is not necessary that an animal body should have motion to assure us of its animality, or that it sustains vitality; since life, in some of the lower order of beings, is so infinitely diffused and variously modified; at the same time that animal ac-

* Mr Ellis speaks with certainty as to the contractive and expansive property of one species, the *cristata*.

tion is so extremely limited, as to create doubts of its existence *.

The actual distinction between animal and vegetable life, is perhaps so small and indefinite, that the physiologist will scarcely venture to say where the one terminates, and the other commences: the only material distinction between them appears to consist in their constituent parts.

By chemical analysis, there appears to be an infallible character of specific distinction, by which they are with certainty recognised †. That character, therefore, discovered in all animal matter, has been proved by chemical decomposition to exist in sponges ‡. Motion, as already observed, is not essential to animality; and in their inertion, zoophytes, especially sponges, approximate so nearly to ve-

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* Vitality is not affected by separating any part of zoophytal animals, no more than in Hydra: each fraction contains an equal portion of vitality independent of connexion. In the higher order of beings, vitality is limited.

† "I need not," says Mr Ellis, when speaking of the chemical experiments on *keratophyta*, "mention any other to the curious, than the great quantity of volatile salts that may be extracted from them, and the strong smell they yield when burnt, of roasted oysters."

‡ The odour produced in the combustion of sponges, and other zoophytes, is similar to that of other animal substances, mixed with a peculiar marine odour, well exemplified by oysters roasted in their shells; and which is very different from the effluvia of burning vegetable matter.

getables, that it is only the peculiarity of their constituent parts (which we are enabled to discover by the aid of chemical science) that separates them. It is not essential to the formation and growth of animal substance, that a heart, brains, or even intestines, or any viscera, should exist, no more than it is, that all vegetables should possess roots.

Many species of *alcyonium* appear to be destitute of motion except in that part termed the polypi; and yet these only constitute a small proportion of this multifarious animal; for the basis from which these animated portions issue, is equally formed of the same material, also endued with the principle of animal life. Were it not for the multifarious polypi that constitute a part of *alcyonium*, the characters of distinction between that and *spongia*, would be more indefinite.

Whether motion has ever been discovered or not in any species of sponge, is not I conceive of so much importance as some naturalists would appear to consider. Those who are solicitous in their inquiries after the animals which they have supposed to construct the vesicular fabric of sponges, and have expressed their surprise, that in this age of cultivated science, no one should yet have discovered,—must have taken a very limited view of matter possessing vitality, and have grounded their hypothesis only upon supposed analogy. Why should it be concluded that sponges are only the *nidi* of insects or vermes; or why

should not organic matter possessing vitality without action, exist? If these philosophers expect to find polypes, or vermes of any kind, to be the inhabitants of Sponges, they will be deceived. The true character of spongia, is that of a living, inactive, gelatinous flesh, supported by innumerable cartilaginous or corneous fibres or spicula, most commonly ramified or reticulated, and furnished more or less with external pores or small mouths, which absorb the water, and which is conveyed by an infinity of minute channels or capillary tubes throughout every part of the body, and is there decomposed, and the oxygen absorbed as its principal nourishment, similar to the decomposition of air in the pulmonary organs of what are called perfect animals.

The food of sponges must be similar to that of plants; for a Sponge has no more power to digest gross bodies, than a Fucus or a Conferva; and nothing can be more admirably adapted to a gaseous aliment than the construction of a sponge. The conformation of a sponge, better entitles it to the appellation of *sea-lungs*, than any other marine production; since the water absorbed by its capillary tubes becomes as greatly divided, as air respired by pulmonary organs; and thus by such an extensive surface offered to the water, decomposition may be effected in the same way as air is decomposed in the lungs of terrestrial animals.

Having advanced an opinion upon the constitution of sponge, it must be observed, that I have not enumerated what has been usually considered as fresh-water species of this genus, in my catalogue of British sponges, conceiving that they are actually of a different nature. Lamarck has separated these from *Spongia*, and has placed them in a new genus denominated *Cristatella*, which bears evident polypes. Bosc, however, conceives Lamarck has been deceived by a figure in Roesel, as he declares that he has examined a vast quantity of what is called *Spongia fluviatilis*, and never could discover animal organization with signs of life.

Not having had an opportunity of examining recent specimens of these fresh-water species of supposed sponges, I must confess that, by the structure alone in an *arid* state, I am led to an opinion that they do not truly belong to the genus Spongia *.

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* This fibrous brittle substance is evidently of animal origin, by its odour in combustion: the numerous minute globules it contains of the same figure and size, interspersed throughout the whole substance, have evident characters of *ova* connected together by glutinous filaments, which form the reticulated mass. If these minute globes were cells of polypes, or any other perfect animal, they would possess an aperture; whereas they have no opening. They are strong, tough, and polished within, like what the remains of a glareous matter would be when dried in

I shall now proceed to give a description of the several species of sponges that have been discovered to inhabit the British Islands.

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so small a body. It appears to me, that this substance is in fact the nidus of some aquatic insect, which may possibly congregate to deposite their eggs; and that the fibres, or threads that decussate each other, are attached to the *ova* for their security in mass, as we perceive in those of some spiders and other land insects.

SPONGIA

## SPONGIA BRITANNICA.

In order to facilitate the arrangement of the species, I have divided them into the following families;

1. Branched; those which are properly branched, simple or compound.
2. Digitated; those which are divided into lobes or leaves, on their sides or on the summit.
3. Tubular; such as shoot into tubular processes, whether simple or compound.
4. Compact; such as are destitute of any divisions, and are of a compact form, but of indefinite shape, whether of an open or a solid texture.
5. Orbicular; such as are globose, with internal, radiating, asbestine spiculæ.

### * Branched.

1. *Oculata.* Much branched, soft, the branches roundish and obtuse, furnished with marginal pores.

Plate vi. fig. 2.

Spongia oculata. *Ellis*, Coral. p. 80. t. 32. fig. F. f.—*Id.* Zooph. p. 390.—*Gmel.* p. 3820.

In all the specimens I have examined, some of the branches originate from the base, but have a

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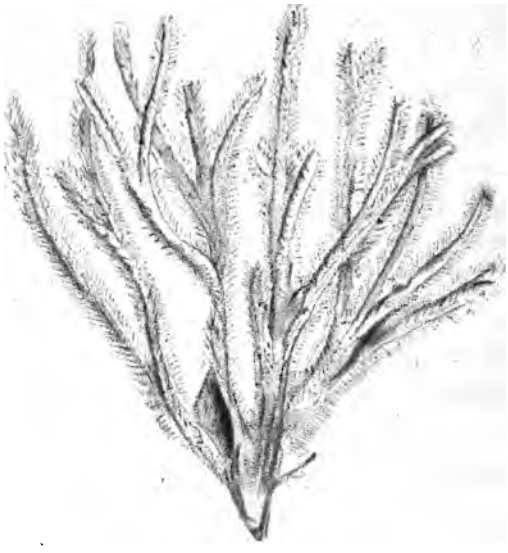

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listinct stalk, which is composed of tougher materials, the fibres being ligneous and longitudinal. An elegant variety in my cabinet, is of a pale brown colour, with numerous divarications; some of these unite for an inch or more, and then separate, and spread at their tips into four or five small branches, with obtuse summits. The growth of this variety differs so much from the general appearance of *Spongia oculata*, that, were it not for the stalk, similarity of texture, and the marginal cells on the branches, it might have been considered a distinct species. The stem is destitute of branches for three inches; the branches are six inches long. This, and the common sort, are found on the coast of Devon.

2. *Stuposa.* With round branches of tow-like appearance, covered with pointed hairs.

Plate iii. fig. 1.—Plate iii. fig. 2. var.—Plate iv. var.

Spongia stuposa. *Ellis*, Zooph. p. 186.—Phil. Trans. 55. p. 288. t. 10. c.—*Gmel.* p. 3822.

What is considered as an elegant slender variety of this species, is beautifully white, and has the branches more ascending, and more tomentose. Perhaps it is the older specimens that become palmated at the divarications, like the antlers of a buck. Both these sponges may be likened to the horns of deer in their soft or velvety state, and one is probably the *Spongia cervicornis* of Pallas. If hereafter these should prove to be different

species, the palmated kind might be called *damacornis*. Coast of Devon, rare.

3. *Palmata.* Palmated, with finger-like divisions on the margin, and little prominent pores irregularly disposed.

Spongia palmata. *Ellis*, Zooph. p. 189. t. 58. f. 6.—*Gmel.* p. 3822.

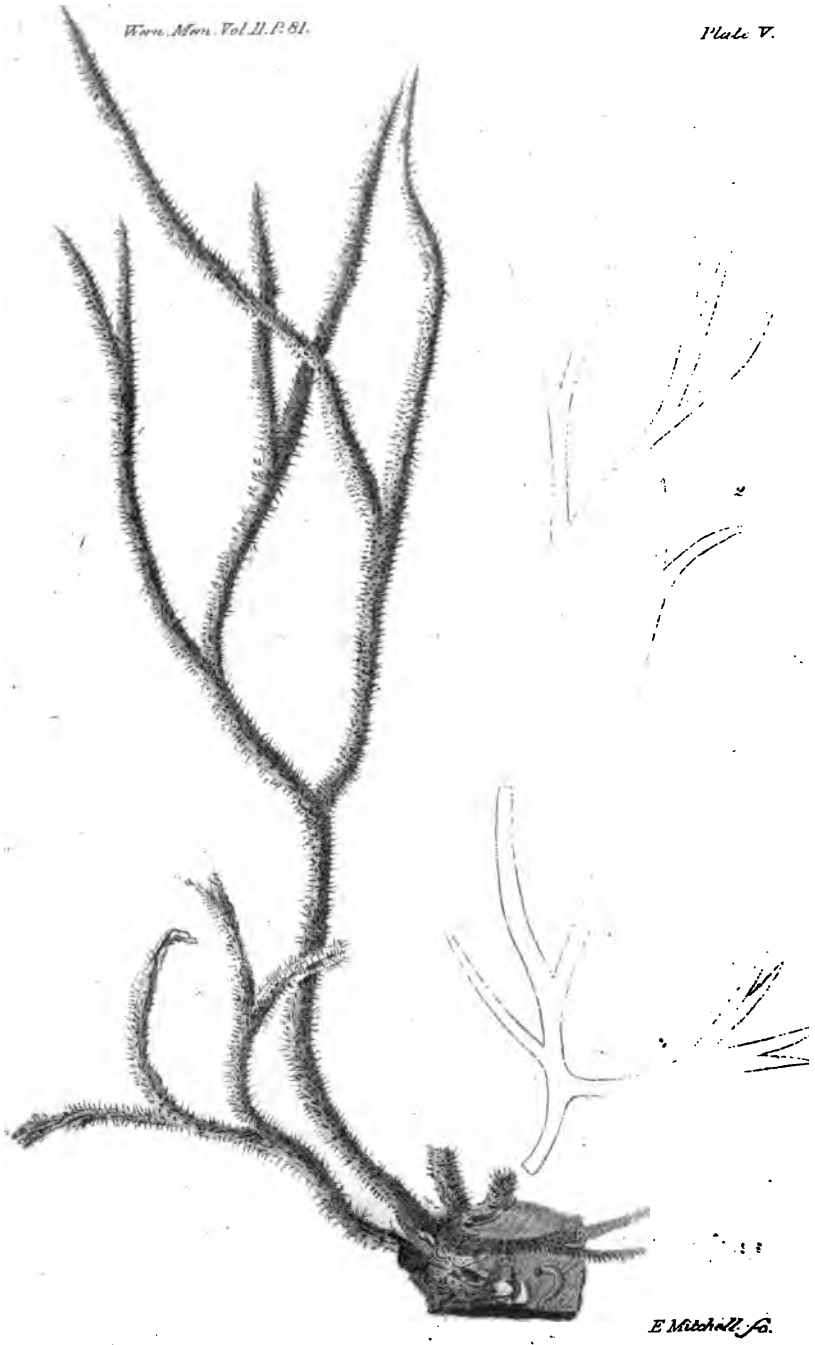
This, in some of its varieties, somewhat approaches *Spongia oculata*, is of a similar texture, but not so soft when dry, and the pores more numerous, and disposed all over the surface. Coast of Devon, rare.

4. *Coalita.* Much branched in an irregular and distorted manner, rather compressed, and of a brittle corky substance.

Spongia coalita. *Gmel.* p. 3825.—*Müll.* Zool. Dan. iii. t. 120.

This species is much branched, and composed of finely reticulated fibres, with seldom any larger pores: the stalk is scarcely larger than the branches, and both usually become sub-carinated at the sides, on which part a few porous tubercles are sometimes observed: the branches are frequently hooked, and turn in different directions, but preserve a flattish form. Coast of Devon, rare.

Müller is certainly mistaken in referring this to the *oculata* of Ellis.



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5. *Hispida.* With long, slender, round, dichotomous branches, covered with stiff hairs.

Plate v.

This slender branched sponge appears as if it sometimes grew horizontally on each side from the point of adhesion, which is very slight; in this case, both ends become branched. Others rise perpendicular from the base, which is attached to old shells; in some instances several stalks originate from the same spreading base, but are rarely connected: the branches are nearly round, except where they divaricate. Three, and sometimes four subdivisions take place in the larger specimens; the points of the subdivisions are subacute. Length, a foot or more.

When recent, contains a great deal of gelatinous flesh, and is of a yellowish-brown colour, becoming darker as it dries. The only specimens that have occurred, were taken off the coast of Devon by the trawl; rare.

The description given of *S. tupha*, would tolerably well accord with this, had not that species been stated to be soft, whereas this is hard, and not composed of so fine a texture as S. oculata, and is thickly muricated with hairs.

6. *Dichotoma.* Branched, erect, subcylindric, tomentose, and covered with small pores.

Spongia dichotoma. *Ellis*, Zooph. p. 187. 6.—Phil. Trans. 55. p. 289. t. 11. f. 1. (*Ellis.*) Lin. Syst. p. 1299.—*Berken.* p. 213.—*Gmel.* p. 3822.

Plate vi. fig. 1.

Brown, with long erect dichotomous straight branches, smaller at their summit: at the divarication of the branches it spreads a little, becoming compressed, but never so much as *S. oculata*; from which it also differs in the superior length and straightness of the branches; the texture is also more firm and less woolly. The *dichotoma*, like the *oculata*, originates from a compact ligneous stalk, an inch or two in length, but the branches are truly dichotomous, and they never terminate in more than a fork, and most frequently in a single point; whereas the *oculata* is much more complicated in its branches, which are more compressed, and sometimes inosculate, and their tips become digitated in older specimens; in some the ends are palmated, from which issue four or five fingers. In both these species, numerous branches arise together from the top of the main stalk: in the *dichotoma*, the first subdivision or offset from a main branch, commences close to the base, and another divarication takes place at the distance of two or three inches; but many of the main branches have only a lower divarication, and from thence extend nine or ten inches per-

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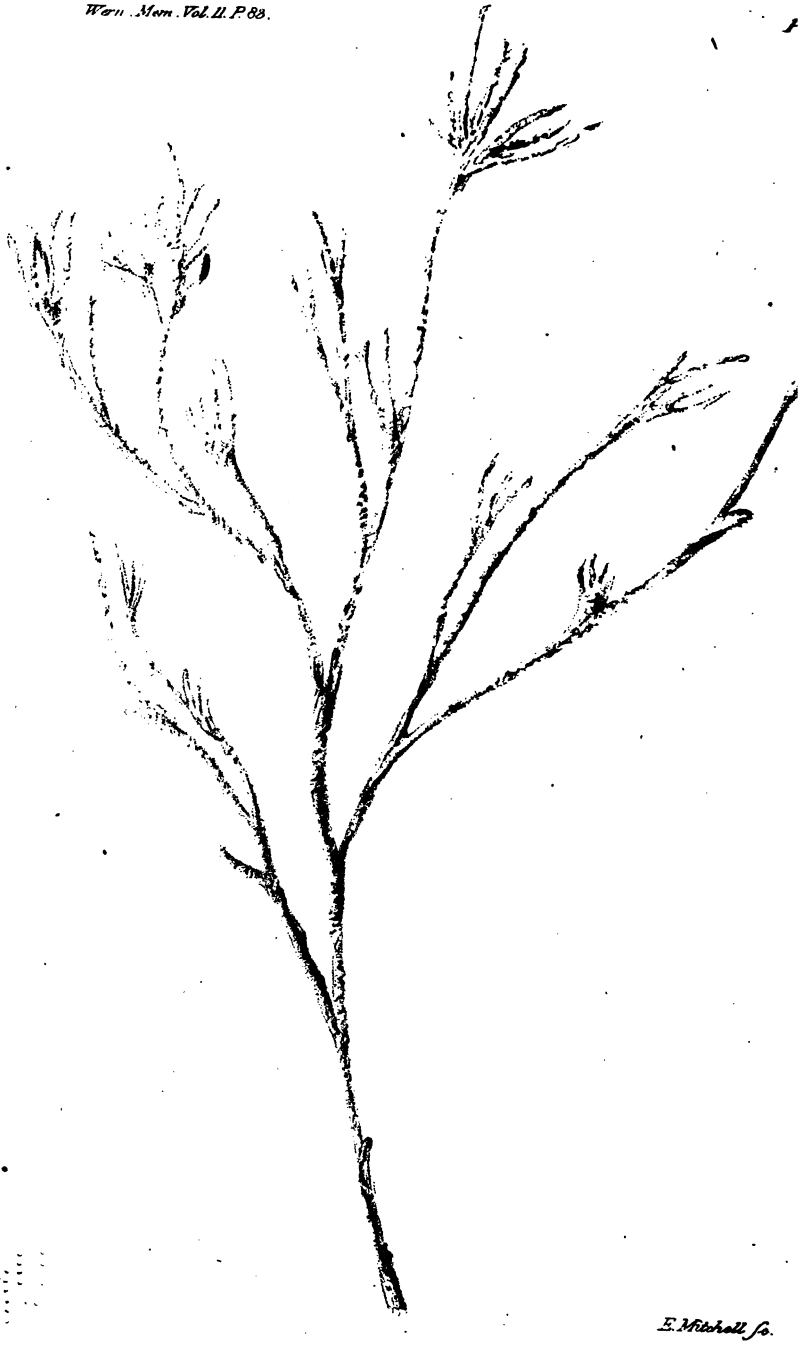
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fectly straight, and gradually tapering to a point. A specimen in my cabinet, taken on the coast of Devon, has not less than a dozen main branches, some of which are eleven inches long. A figure of a branch of this, and of the *oculata* *, are given together, in order to shew the difference of their usual growth, as it is probable they have sometimes been confounded.

A comparative description has been considered in some degree essential for the discrimination of these two species, as the *dichotoma* has not, I believe, been considered as British, but was originally described by Mr Ellis as a production of the coast of Norway. The rows of cells which the *oculata* is described to possess on the margin, and which project a little, does not form a character of distinction, being equally applicable to *dichotoma;* but perhaps in this last, the cells are more disposed over the whole surface. Both species are yellowish when fresh.

Berkenhout is the only one who mentions this species as a native of the Cornish and Yorkshire coasts, but on what authority we are not informed.



* Plate vi. fig. 2.

7. *Digitata.* With very slender dichotomous branches, digitated at their summit; the surface granulated.

Plate vii.

This very slender sponge is tough and flexible; neither the stem nor the branches are so large as a medium straw, slightly compressed; the branches are distant, and usually terminate in a cluster like the foot of a bird; these slender terminal divisions, are from three to six in number. It is compact in its texture, and when examined under a microscope, appears granulated on the surface, as if sprinkled with fine sand: the base of the stem is usually ferruginous, the rest of a pale yellow-brown.

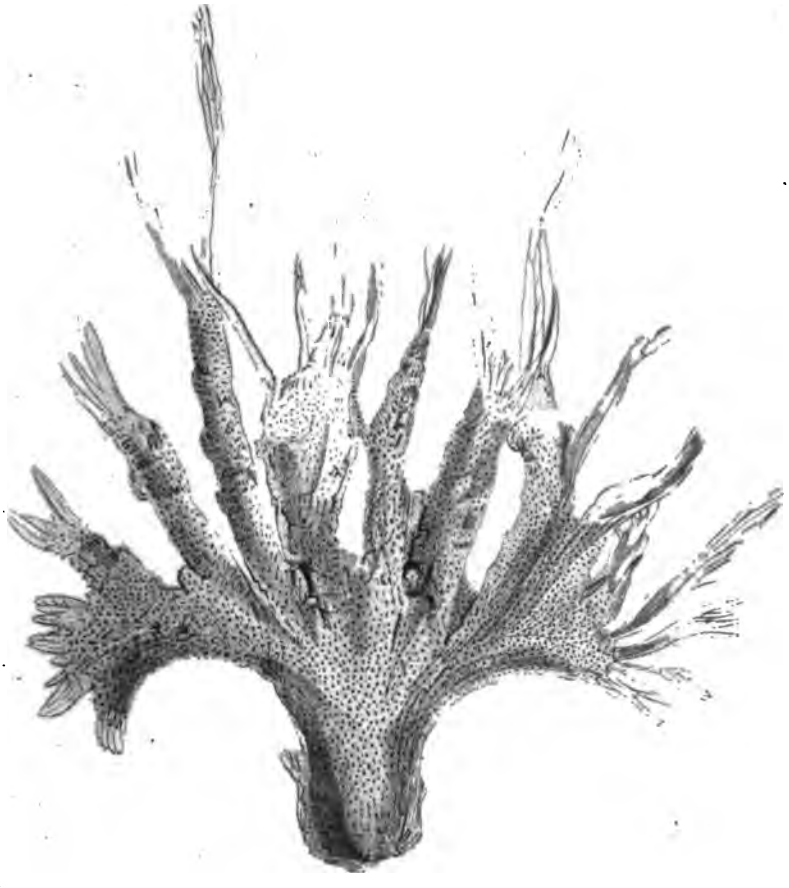
Taken in deep water by the trawl off the coast of Devon; rare.

8. *Ramosa.* Palmated and digitated round the top.

Plate viii.

This curious sponge is stiff, and somewhat elastic; the interior part is ligneous, striated longitudinally, and which is always bare at the ends of the ramifications, where it seems to be composed of numerous fibres that frequently split and divide into fascicles: the spongy or exterior part is of a fine texture: colour pale yellow-brown.

This singular species, which appears to be undescribed, I first noticed in Mr Boyer's cabinet of British shells, chiefly found at Weymouth. I have since taken a larger and more perfect specimen on the coast of Devon, measuring nearly five inches in height.



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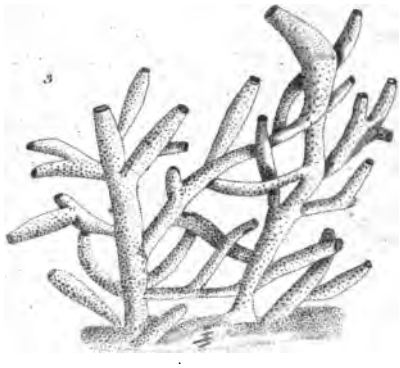

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** DIGITATED.

9. *Conus.* With numerous short flattish divarications issuing from the sides.

Plate x.

The divarications are irregular in size, shape, and situation, but they are usually compressed, short, and broadest at the end; these sometimes originate from an irregular stalk, giving a little resemblance to an expanded fir cone: the texture is rather coarse, and the outside furnished with spiculæ or short bristles. When dry it becomes stiff and rather hard, owing to the large quantity of gelatinous flesh which is obvious amongst the fibres. Colour when dry, of a dark yellowish-brown.

Coast of Devon; rare.

10. *Lobata.* With clustered ovate divarications.

Plate ix.

The texture of this sponge is rather more coarse than that of *oculata;* the lobes vary from ovate to oblong, and originate from an ill-defined stalk in an irregular manner; they are nearly connected, sometimes inosculate, and are furnished with a few prominent pores without order. Colour, yellowish-brown; height two inches.

Devon coast; rare.

11. *Perlevis.* Form indeterminate, texture close, surface covered with obtuse papillæ.

In texture, this sponge is somewhat similar to *tomentosa;* is equally light, but not so soft and crumbly, nor of so pale a colour; when fresh it is yellow, becoming of a light brown when dry: on the surface are numerous obtuse papillæ, the eighth of an inch in length; these are not tubular, but of the same texture as the rest of the sponge; some are clavated, others bifid or trifid, and compressed; sometimes a few moderate sized pores are scattered over the surface, very visible to the naked eye, being as large as if made by a common pin.

A specimen of about two inches long and an inch broad, taken on the coast of Devon, appears to have been attached to a rock its whole length.

12. *Aurea.* Broad, flat, and slightly divided at the top.

Two or three inches broad, and nearly two inches high, of an orange-yellow when fresh, fading to brown when dry. Sometimes its slight divisions are tubular, but this is of rare occurrence. It is not so much divided as *Spongia prolifera* of Ellis, or might be thought a variety; but in this, the base is always broad and compact, and the summit is more ragged than branched; it con-

tains a great deal of animal gluten, which in drying, contracts and connects the small divisions.

Plentiful in the estuary of Kingsbridge, covering the stones at low water.

13. *Rigida.* With obtuse, spreading irregular flattish divarications, arising from the same base; usually a short stalk.

Plate xi. fig. 1, 2.

This sponge is as coarse in texture as *Spongia officinalis*, and when fresh, is of an orange colour, which it partly retains if tolerably freed from the animal gluten: the divarications are irregular in size and shape, but usually originate from one base or stem. When dried, it becomes rigid, but less so when it has been exposed for some time on the sea-shore, or, by repeated irrigation, the animal gluten is decomposed and washed out.

Height, about an inch.

What is conceived to be a small variety, has the divarications more numerous and distinct, spreading from a short pedicle. In this, the reticular fibres are greatly obliterated by the large quantity of gelatine retained, by the contraction of which, the fibres are connected, and the sponge is rendered hard and destitute of flexibility.

Coast of Devon; rare.

### *** Tubular.

14. *Corónata.* A single tube, the summit crowned with radiating spines.

Spongia coronata. *Ellis*, Zooph. p. 190. t. 56. f. 8, 9. —*Gmel.* p. 3819.

This curious little sponge, originally discovered by Mr Ellis in the harbour of Emsworth, is not uncommon on many parts of the British coast; I have found it in the most southern extremity, and have been favoured with it from Zetland by Mr Fleming. The specimen figured by Ellis, is very diminutive; it is usually larger, and one in my cabinet is above an inch in length, but not near so large in proportion as the magnified figure in the *Zoophytes*. It should be remarked, that the specific character of being "surrounded at top by a crown of spines," is rarely identified; but the spiculæ that cover all other parts, form a lasting character. It is generally of a yellowish colour, sometimes of a shining silvery white; and this we may conceive is its true colour, could all adventitious matter be removed.

Found on fuci and other marine bodies.

15. *Botryoides.* Minute, ovate, tubular, in bunches, covered with triradiated spines.

Spongia botryoides. *Ellis*, Zooph. p. 190. t. 58. f. 1.–4.—*Gmel.* p. 3823.

This species, originally described by Mr Ellis, is the only one I have not been able to identify amongst the sponges that zoophytist has given as British. It is very minute, and composed of branches of little oval figures in the shape of grapes, and each is open at the top, (probably tubular.) "When the surface of this species is highly magnified, it seems," says Mr Ellis, "as if covered with little masses of triple equidistant shining spines." These spines were described and figured by Walker in *Testacea Minuta Rariora*, as a minute species of *Asterias*. My late valuable friend Mr Boys of Sandwich, favoured me with specimens of these triple spines, together with most of Walker's minute shells, and they were admitted by that able naturalist to be the spines of *Spongia botryoides*. I do not recollect that Mr Boys had ever seen a perfect specimen of this sponge, nor is it mentioned in his Catalogue of subjects in Natural History in the neighbourhood of Sandwich; but Mr Walker says his *Asterias triradiata* is found on all the shores of Kent; so that we may conclude the sponge is not uncommon in that quarter.

16. *Papillaris.* Sessile, flat, spreading, with scattered tubulous tubercles.

Spongia papillaris. *Gmel.* p. 3824.—*Pallas*, Zooph. p. 391.—S. compacta, Br. Miscel. 1. t. 42?

This sponge is usually attached to rocks, sometimes intermixed with *Corallina officinalis* and others, spreading three or four inches. In a recent state, it is soft and yellow, the tubercles occasionally tipped with blue: when dry it becomes less soft, and turns to a brown or grey colour. When examined by a lens, the surface appears like gauze: the papillæ are various in size, hollow or tubular, and disposed without order.

Common on the south coast of Devon on the rocks that are rarely left by the receding tide.

It will be perceived, that part of the synonyma prefixed, is given with doubt; but we suspect from the appearance of the *compacta* figured by Mr Sowerby, that it is really a fine variety of this species; the surface appears to be the same, and the difference consists in the tubercles being more lengthened, more numerous, and more connected. This fine variety, (as I suspect,) was probably thrown up from the deep, where all marine subjects of this nature, arrive at much greater perfection than nearer the shore, where the continual agitation of the water causes depauperation.

17. *Tubulosa.* Tubular, branched, tough; the tubes erect, and slightly tapering.

Spongia tubulosa. *Ellis*, Zooph. p. 188. t. 58. f. 7.—Lin. Syst. p. 1297.—*Gmel.* p. 3819.—Spongia fastigiata. *Pallas*, Zooph. p. 392.

The external structure of this sponge is so fine as not to be discerned by the naked eye; smooth, and destitute of any detached fibres; when examined by a lens, it is observed to be finely, though irregularly reticulated with smooth fibres: the tubes are hollow throughout, nearly erect, and most commonly originate from a common base, but frequently so close together, as to become more or less united; sometimes smaller tubes issue from the sides of the larger: at the summit the tubes are as thin as paper.

This sponge is not uncommon in the estuary of Kingsbridge at very low water, adhering to stones, and is occasionally taken by the trawl in the open sea on the coast of Devon. It rarely exceeds three inches in height, and four or five inches wide; one specimen contains ten principal tubes of different lengths: the colour when fresh is yellow, but, by drying, it becomes of a pale brown or dirty white.

Making allowance for climate, this approaches so nearly to the Batavian tubular sponge, that I have ventured to consider it a depauperated variety of the species described by Mr Ellis, rather

than run a risk of unnecessarily multiplying species without evident specific distinction.

18. *Foliacea.* Of a fine texture, greatly compressed, and tubular; the inside finely reticulated.

Spongia compressa. *Fab.* Faun. Groenl. p. 448?—*Gmel.* p. 3825?

Plate xii.

This leaf-like sponge usually grows in clusters, each follicle being of an irregular shape, but generally more or less obovate, furnished with a short pedicle, by which it is affixed; and the apex is contracted, having an opening to the tube: some specimens have one or two perforated tubercles on the lateral margin; others shoot into small lateral leaflets, which are also tubular.

The remarkable character of this sponge, is that of being so thin or compressed, as at first sight to be mistaken for a fine *Flustra*, and yet being hollow. Its colour is dull yellow when alive, and in that state, when adhering to the under part of projecting rocks, has so much the appearance of a young *Flustra foliacea*, that it might readily deceive an experienced eye without close inspection. It rarely exceeds an inch in length, and is of a fine texture. It is frequently mixed with stunted fuci, growing in the most exposed situations, subject to the severest agitation of the waves, and is always observed to be pendent.

E. Mitchell, fc.

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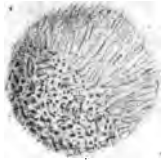

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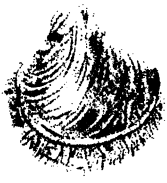

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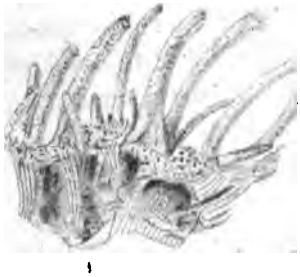

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4

6

E. Mitchell

The only place I have noticed this sponge, is at Dawlish in Devonshire. This is probably *Spongia compressa* of Fabricius? which is mentioned as a production of the Scotish coast in Professor Jameson's catalogue of Vermes, given in the first volume of the Wernerian Natural History Memoirs.

The Reverend Mr Fleming favoured me with a very fine specimen on a fucus from Zetland, under the denomination of *Spongia compressa*. The interior surface of this tubular sponge, is elegantly reticulated, having the pores larger than on the outside; and, when highly magnified, is found to be formed of aggregate, simple spiculæ.

19. *Penicillus.* With a yellowish gelatinous base, supported by internal spiculæ, and bearing on its surface erect, white, flexible, spongy tubes.

Plate xiii. fig. 7.

This is an interesting species of Spongia, as its internal conformation appears clearly to demonstrate its great affinity to *Alcyonium lyncurium* and *cydonium* of Linnæus; while its exterior part is evidently that of a tubular sponge. It must be confessed that I had long considered those *Alcyonia*, as more properly belonging to this genus; but as the asbestine spiculæ with which their interior part is crowded, and the firm fleshy appear-

ance of the exterior part, differed somewhat from the generality of Spongiæ; and as no radiating pores or polypi could ever be discovered, it was in contemplation to form them, and one or two others, into a distinct genus. The discovery of this new species of Spongia, induces me to recall my assent to the formation of a new genus for those obscure species originally considered by Linnæus as Alcyonia; but by removing them into this genus, we shall follow the course of nature, and accord with the opinion of that great zoophytist Mr Ellis. This high authority has, in a few words, defined the leading characters of the *Alcyonium* and *Spongia*, and pointed out their distinction. Speaking of *Alcyonium* in his introduction to *Spongia*, "These polype suckers," says this naturalist, "are the distinguishing characters of that genus, as much as the pores without the polypes in these elastic fibrous bodies, is the character of sponges." With this strongly marked character, stamped by so able and experienced a zoophytist, we cannot hesitate to remove those of the fibrous kind destitute of polypes from *Alcyonium* to *Spongia*; and if ever Mr Ellis himself had the smallest doubts upon the subject, such would have been removed by the examination of *Spongia penicillus*.

The interior substance of this species, is precisely that of *Lyncurium*, but instead of being orbicular, it spreads horizontally upon marine bodies, and shoots upwards from its surface cylindric

tubes of nearly an inch in length, which have an opening at the apex; these tubes are distant, and not disposed in regular order, nor of any determinate size; but on the same specimen may be observed tubes from the eighth of an inch upwards, in all gradations, to the length before mentioned. In drying, the tubes become compressed and a little arcuated, and all incline the same way; they are flexible, tough, and the texture extremely fine. The spiculæ that support the fleshy part, appear to be the base or continuation of the tubes; perhaps these are ligaments, and may contribute to give some small action to the tubes, by inclining them to either side, or by expansion and contraction. When first separated from the rocks, the asbestine-like spiculæ are not so obvious as when the flesh is contracted by drying. In its general appearance, this sponge bears some resemblance to Lichen filiformis.

The only specimen was taken by dredging, and is an inch and a half in length.

20. *Lævigata.* Soft, compressible, and elastic; texture extremely fine and reticulated.

Plate xvi. fig. 4.

This is the most delicate of all the soft British sponges; when compared with either *oculata* or *dichotoma*, their texture is extremely coarse; by the naked eye, the surface appears nearly smooth, or finely frosted; when examined with the double

lens of a megalascope, the surface is found to be minutely and elegantly reticulated, and of a cottony softness, but the fibres are infinitely finer than common cotton. Perhaps the texture in fineness would be more aptly compared to the interior spongy part of some species of puff-ball (Lycoperdon.)

The only small piece of this sponge that has come under observation, is tubular throughout; whether this is its natural habit, or the consequence of being a parasitical species that surrounds the stalks of fuci, or other marine plants, has not been discovered; but it is observable, that the central fibres radiate to the circumference; the summit, however, is rounded and perfect, like the finish of an independent species.

Imperfect as the specimen is from which this description is taken, it is distinct from any I am acquainted with, and therefore cannot be omitted. Till its habit is better known, it has been thought proper to place it amongst the tubular sponges.

21. *Ananas.* Ovate, rugous, tubular, the summit crowned with spines surrounding the aperture.

Plate xvi. fig. 1, 2.

This elegant minute sponge, is nearly allied to *coronota*, but is very different in shape and texture; the surface is not covered with spiculæ as in that species, but is apparently vesicular or scaly, and

when magnified, somewhat resembles an extremely fine *Millepora*, except that no openings or pores are visible, nor is it of the same consistence.

The size is expressed in the figure referred to, as also its appearance when magnified.

Devon coast; rare.

Var.? With this, a figure is given of a white tomentose tubular sponge, which is suspected to be the same species in a more perfect state; should it hereafter prove so, the leading characters may require revising. It is affixed to *Cellaria scruposa*, as represented at fig. 3., highly magnified. The shape is sufficient to separate it from *Spongia coronata*, which is invariably subcylindrical.

22. *Complicata.* Tubular, with numerous branches, most complicately interwoven, and frequently inosculating.

Plate ix. fig. 2, 3.

This species is minute, of a very fine texture, and, when dry, is observed to be formed of shining white spiculæ. It is tubular throughout, and the branches are subcylindric, with an opening at the apex, and are frequently bifid, and sometimes trifid: the principal stems originating from distinct bases, throw out lateral branches that anastomose with each other, and then a most complicated communication is obtained throughout a large cluster. When bruised and reduced to fine powder, and the particles highly magnified, many tri-

radiated spines are observable. This circ
stance might favour an opinion, that the pr
subject is only a variety of *Spongia botry*
Mr Ellis, who first discovered that species, rem
that when that sponge is examined under a
croscope, the whole surface is observed to b
vered with triradiated spiculæ. I could not
cover any such superficial spines in *Spongia*
*plicata;* and those triradiated spines which
observed, are not a quarter so large as thos
longing to *botryoides*. It must be confessed,
I have never been able to procure *botryoide*
though I am in possession of its triradiated
culæ, originally sent to me by my late w
friend Mr Boys, for the minute *Asterias* fig
by Walker. If, however, an opinion ma
formed from the representation of *botryoid*
Ellis's Zoophytes, there appears to be a very
siderable distinction between the two species:
is a cluster of little oval figures occasio
branched, but all its parts retaining an ovate
and nothing either in description or figure,
sents the complicated cylindrical, and frequ
inosculating tubes which characterise *compli*

This elegant little sponge was found in Ze
by Mr Fleming, adhering to fuci, to whom
under obligations for a clustered specimen,
taining innumerable principal stalks, all mo
less uniting in the manner the two here sel
are represented.

****** COMPACT.**

23. *Tomentosa.* Irregular, soft, brittle, and full of pores interwoven with minute spines.

Spongia tomentosa. Lin. Syst. p. 1299.—*Gmel.* p. 3821.

Spongia urens. *Ellis*, Zooph. p. 187.

Sponge like crumb of bread. *Ellis*, Coral. p. 80. t. 16. f. d. d. 1. D. 1.—Phil. Trans. 55. p. 288. t. 10. f. A.

Spongia panicea. *Pallas*, Zooph. p. 308.—*Gmel.* p. 3823.—*Turt.* 4. p. 660.

This species of sponge is so amply described by Mr Ellis, that little needs to be said of it; but it may be proper to remark, that the minute spines of which it is formed, and which are said to sting and blister the skin like cow-itch, is not readily discovered except in the larger pores; nor do they always affect the hand by which the sponge is rubbed, for it is only in a very dry state that such an effect is obvious; hence, as Mr Ellis remarks, the property of stinging, is much increased by drying in an oven.

It is suspected that this sponge has been commonly confounded with *Spongia suberia*, though in fact not the least like when compared, either in colour, (when dry,) or in texture; a definitive comparison will be found in the description of *suberia*.

formed between the period of its being quitted by one inhabitant, and the possession of another; for the hermit-crab is continually changing its abode, in order to accommodate its cell to its growth.

In every instance where a crab has been found to inhabit such a shell, the sponge has invariably spread within the aperture, and frequently a considerable extension of the lip to the shell, is produced by the sponge.

This species of sponge is found on several parts of our coast, which makes me suspect that it has been confounded with *tomentosa*, as it does not appear to have been described. It is not uncommon in the estuary of Kingsbridge, and is frequently taken by the dredgers.

*Spongia suberia* differs from *tomentosa* as much in its habits as in its texture: it never appears to attach itself to any fixed body; no part of its surface ever indicates such an attachment; and consequently, we may conclude it is not sessile, but independent. It is ponderous (comparatively speaking) even when dry; it has no visible pores to the naked eye even in fractured parts; and its surface is regularly smooth without any little indentations or inequalities, and is hard to the touch.

The *tomentosa*, on the contrary, is always affixed by its surface, is not very fine in its internal texture, is extremely light, brittle, and soft, and its surface full of small inequalities.

rown when dry: its shape is indefinite, but it as the singular property of being attached only as far as I have been able to ascertain) to old univalve shells, which it entirely invests. It is also remarkable, that few instances occur, where the Hermit-crab has not formed a lodgement in the nucleus shell, and there appears to be a great struggle between the two parasitical intruders, as the sponge is continually endeavouring to fill up the aperture of the shell, while the crab, by its occasional motion in search of prey, frustrates that natural propensity of the sponge. Notwithstanding the efforts of so active and restless an intruder, the gradual and insensible increase of the sponge gains upon the premises of the crab; it pushes in on all sides, and completely lines the interior surface of the shell, so that the crab soon finds its habitation too small, and is compelled to search for a more capacious house.

The species of shell may frequently be traced, which constitute the nucleus of this sponge. *Buccinium reticulatum* and *undatum*, *Turbo terebra* and *littoreus*, are frequently covered by this sponge, except more or less opening to the aperture of the shell.

It is a curious circumstance, that no instance has occurred where this sponge has been attached to a living shell, or such as were inhabited by its proper animal. Either the increase of the sponge must be very rapid, or its efforts to inclose the aperture of a shell, must be most successfully per-

formed between the period of its being quitted by one inhabitant, and the possession of another; for the hermit-crab is continually changing its abode, in order to accommodate its cell to its growth.

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25. *Cristata.* Flat, erect, and tender, resembling a cock's-comb, with rows of small holes that project a little, along the top.

Spongia cristata. *Ellis*, Zooph. p. 186.—*Gmel.* p. 3822.

Cock's-comb sponge. Phil. Trans. 55. p. 288. t. 11. fig. G. *(Ellis.)*

The description of this sponge, given by Mr Ellis, renders it needless to add any thing further, than to remark, that this appears to be the only species of *Spongia* in which Mr Ellis ever discovered actual signs of motive power. "When it was taken out of the sea, and put into a glass-vessel of sea-water," says Mr Ellis, "I perceived it to suck in, and squirt out the water through the rows of holes or little mouths along the tops, giving evident signs of life."

Coast of Sussex.

26. *Infundibuliformis.* Funnel-shaped, flexible, with the surface more or less roughened and irregular.

Spongia infundibuliformis. Lin. Syst. p. 1296.—*Gmel.* p. 3818.—Nat. Miscel. iv. t. 145.—Wern. Mem. i. p. 562, *(Jameson.)*

Spongia crateriformis. *Pallas*, Zooph. p. 386.

For the first time, this sponge has been publicly announced as British by Professor Jameson, who found it on the shores of the Island of Unst, Zetland. I have also been informed that Mr

Neill is in possession of a specimen which he found in Orkney. On such authority, it now becomes enrolled as a British sponge.

It must, however, be recollected, that shape alone in such variable subjects, is not always to be depended on; and I am inclined to suspect, that some other sponges, which occasionally assume a crateriform shape, have been confounded with *infundibuliformis*.

*Spongia ventilabrum* sometimes increases with a regular margin from a central stalk, which becomes more or less concave; and as this shape so materially differs from that from whence its name is derived, there is reason for suspecting, that such variety may, for want of comparison, have been confounded with the true *infundibuliformis*. This crateriform *ventilabrum*, Professor Jameson very judiciously remarks, is distinguished by its reticular woody veins, which are wanting in the other, and by the nature of the spongy substance which covers and connects these veins, which in ventilabrum can be rubbed between the fingers when dry; whereas the Linnæan *S. infundibuliformis* is of a flexible elastic nature when dry, and its general consistence approaches to that of the common officinal sponge.

There is, however, another species which approaches nearer to *infundibuliformis*, being equally destitute of woody veins. This accompanied a crateriform *ventilabrum* from a scientific friend in Zetland, who, at first sight, without close ex-

amination, had considered it as the young of that species. The smaller sponge alluded to, is, however, perfectly distinct from either *infundibuliformis*, or *ventrilabrum*, and which will be found described under the title of *scypha*.

Gmelin has referred to *Spongia foliascens*, as well as to *crateriformis* of Pallas, for this sponge; but he is probably mistaken.

27. *Ventilabrum.* Fan-shaped, with reticulated woody fibres, covered with large spongy pores.

Spongia ventilabra. Lin. Syst. p. 1296.—*Gmel.* p. 3817.—*Ellis*, Zooph. p. 188.—Pontopp. Norw. i. p. 251. t. 13. f. 8.—Wern. Mem. i. p. 561. *(Jameson.)*

Sea-fan sponge. Phil. Trans. 55. p. 289. t. 11. H. *(Ellis.)*

This large species of sponge, has been long described as a production of the Norwegian sea; it was therefore very likely to make its appearance on the northern coast of Great Britain, especially in the north of Scotland.

It was reasonable to suppose, that this, and many other natural productions of the coast of Norway, would be found in Zetland, which more particularly approximates that part of the northern continent. This suspicion has been verified, not only by specimens received from those islands through the kind assistance of my scientific friend the Reverend Mr Fleming, but by its having been

lately recorded as a Zetlandic species in the Memoirs of the Wernerian Society. Professor Jameson picked up several specimens of a sponge in the islands of Unst and Fulah, which appears to be the same as those I received from the same quarter. This naturalist, has, it is true, placed a note of interrogation after his reference to the *ventilabrum* of Linnæus. "It has," says Professor Jameson, "the reticular woody veins, the same kind of spongy covering, and the same general fan-like shape as the species *ventilabrum*." The same naturalist remarks, that it is said that certain varieties of this species are funnel-shaped. "It would seem, however," says this enlightened naturalist, "that these supposed varieties belong to a distinct species." May not *Spongia scypha*, hereafter described, be one of the supposed varieties of this species?

It may be proper to remark, that with both the common fan-shaped and crateriform specimens of *ventilabrum* before me, I am confident these actually belong to the same species, although so different in shape. Upon the receipt of these sponges from Mr Fleming, I remarked to him his mistake in considering a small infundibuliform sponge, which accompanied them, to be a young funnel-shaped *ventilabrum*, as its texture is very different, besides being destitute of the ligneous reticulations which form the support of the spongy fibres in that species.

The specimen before me, of a sub-infundibuli-

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form *ventilabrum*, consists of three large lobes, and these more or less divided into irregular smaller ones at the margin, spreading equally from the stalk; the greatest breadth being eight inches and a half, the smallest above seven; the height including the stalk, five inches; the depth of the cavity, three inches.

Another specimen is fan-shaped, but irregularly lobed, having a detached lobe, or a young sponge of about four inches in length, issuing from the top of the stem; and another appears to have been broken off from the opposite side. The height of this specimen is ten inches. Both these sponges are of the same texture, formed by ligneous branches or ramifications anastomosing in a reticulated manner, and covered with the same kind of spongy fibres. They are equally thin, not exceeding a quarter of an inch in the thickest part and much less near the margin; the whole becoming pervious to light, so that objects may be distinctly seen through the pores of the sponge, when held pretty close to the eye.

28. *Scypha*. Rigid, but not woody, originating from a corky base, and spreading into a cup, slightly cut and indented at the margin: pores fine.

Spongia foliascens. *Pall.* Zooph. p. 395?

Plate xv. fig. 1.

The shape of this sponge, is that of an inverted

cone, with a very short stalk, which is of a corky nature internally, but superficially porous like the other parts; the hollow spreads like the bowl of a wine-glass, becoming smaller at the bottom: on the surface, there are some trifling inequalities or depressions, and the margin is slightly and irregularly lobed: in the texture it may be placed amongst the finer sponges, the pores being small, and appearing fibrous when examined with a lens.

The height is about two inches and a half; depth of the bowl nearly two inches; diameter of the margin, the same; that of the base, half an inch; colour, pale-brown.

It may be proper here to remark, that this species is much thicker in all its parts than *ventilabrum*, has the pores of the sponge considerably finer, and so closely interwoven, as to be impervious to light: it is firm, and does not readily yield to moderate pressure, and has no flexibility. With such opposite characters, it can never be confounded with either the crateriform variety of *ventilabrum*, or with *infundibuliformis*; whether this is constant to a cyathiform-shape, must be left for the determination of our northern zoophytists.

The species here described, was, as I have before mentioned, taken by Mr Fleming in Zetland, who kindly favoured me with it amongst other productions of those islands. To that gentleman therefore, we may look with reasonable expecta

tion for information concerning this, and some other species in this intricate class, which are found in that most northern part of Great Britain.

Is not this the younger specimen of *foliascens* described by Pallas?

29. *Pulchella.* Composed of fine reticulations, smooth and soft in appearance, and generally compressed and broad.

Spongia pulchella. Br. Miscel. p. 87. t. 43.—Wern. Mem. i. p. 562. *(Jameson.)*.

This species is described to be extremely irregular in shape, sometimes approaching to fan-shaped, sometimes rather palmated or digitated. Its fibres are delicately reticulated: like the common officinal sponge in colour, it varies from palish-brown to yellowish or reddish brown; from which it is, however, readily distinguished by its less coarse appearance; and its texture may be somewhat more rigid.

Mr Sowerby, who first publicly noticed this sponge, received specimens from Ireland, and from the north of Wales.

Professor Jameson remarks, that Dr Walker first noticed it on the shores of several of the Western Isles.

30. *Cancellata* *. With reticulated fibres, the inosculations tuberous, and furnished with a pore.

Spongia cancellata. Br. Miscel. p. 131. t. 60.

The ingenious author of the work referred to has presented us with a new, and from the figure we may conclude, a very small species of sponge. This cancellated sponge appears to have large interstices between the fibres, and we are told the fibres themselves when magnified, are also cancellated, and have a horny appearance.

The colour is yellowish; and we are informed that it was found at Brighton in Sussex.

Mr Sowerby remarks, that the kneed appearance, and the swelling at the bend of the knee, with the inverted conical aperture, give an assurance that Spongia is more or less the habitation or nidus of some animal. This is not exactly consonant with my ideas on the subject. If the sponge here described could be discovered to be the habitation of polypi or other aggregate or independent vermes, acting by common consent, it would constitute an animal substance differing from that of spongia. The pore, and the tumidity of the fibres at the points of union, are singular specific characters; the former I have

* Not *Spongia cancellata* of Gmelin.

not observed in any species that have come under microscopic examination, and none so completely œdematous as represented by the figure referred to.

31. *Limbata.* With the fibres formed into larger and smaller circular pores, resembling lace.

Plate xv. fig. 2, 3.

This sponge is firm and elastic; but the pores formed by the anastomosing fibres, are considerably large: it is whitish when divided, and its lace-like appearance when examined by a lens, renders it a beautiful object: the pores or interstices of the fibres are circular, and it frequently happens, that numerous small pores surround a large one; and in most cases the intervals between the larger, are filled up with smaller pores. The fibres are smooth, and destitute of any fimbriæ or detached unconnected parts.

A small specimen, or fragment only, of this elegant sponge, has once occurred surrounding the smaller stalk of some fucus.

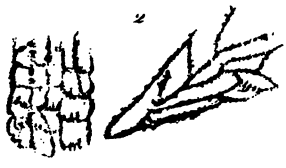
Coast of Devon.

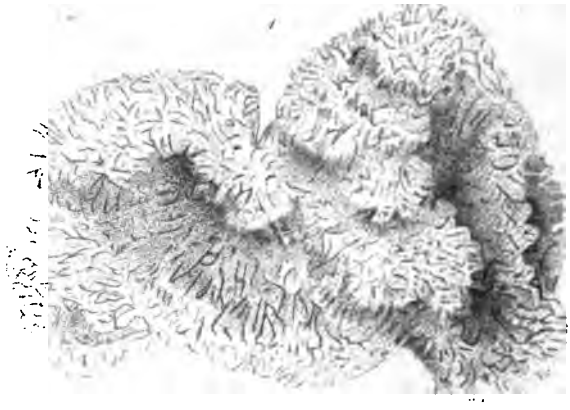
32. *Fruticosa.* Tough, elastic, reticulated, the fibres smooth, slightly connected, and distant.

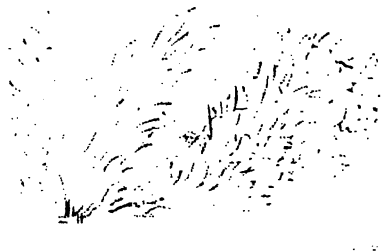
Spongia lichenoides. *Pallas*, Zooph. p. 378 ?—*Gmel.* p. 3824.

Plate xiv. fig. 3, 4.

This sponge is extremely light and elegant in appearance, like a shrubby lichen: the fibres are very distant, so that a large piece is, in a dry state, pervious to light: it is rather more compact about the base, from whence it usually spreads into large lobes, which frequently have the vertical fibres somewhat radiating from the base, and the decussations more distant. From the sinuous appearance of the larger specimens, it seems to attach itself to the stalks of large fuci; but as it inhabits the deep amongst rocks, it has never fallen to my lot to procure a living specimen. After violent storms, it is frequently ejected, and then is sometimes at first brownish, but soon becomes white by the conjoined action of the sun, the air, and the water. In this state, when all the animal gluten has been completely removed, the fibres under a lens exhibit a silky or asbestine appearance, and seem to acquire a superior tenacity. The larger pieces of six or seven inches in length, and half as much in breadth, are rude, shapeless, and usually have the terminating fibres worn away. It is in such older specimens that *Balanus spongia*, described and figured in *Testacea Britannica*, makes







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a lodgement. The fleshy, or gelatinous substance which fills the interstices of the ligamentous fibres of every sponge, has not, that I am aware of, been detected in this species; from whence we reasonably infer, that it comes from the deep, and that, though it may by some accident be removed from its natural fixed abode, it is not ejected till it has lost much of its specific gravity by the decomposition of the fleshy parts, which, from analogy, we may conclude, are readily perishable. The inosculations of the fibres, are extremely variable, and form very irregular reticulations. Besides these uniting fibres, it is thickly interspersed with more minute unconnected branches, arising from the sides and angles of the anastomosing fibres.

This sponge, which is by no means uncommon on the western coasts of England, especially those of Dorset and Devon, I do not find described as a native; but as it agrees in many particulars with *lichenoides* of Pallas, may it not be that species? It must, however, be remarked, that *fruticosa* has a strong animal odour in combustion, whereas we are told, *lichenoides* has a vegetable odour.

33. *Fragilis.* Fragile, friable, coarsely reticulated; the fibres rugose as if covered with minute sand.

Plate xiv. fig. 1, 2.

The above specific characters are sufficient to distinguish it from *fruticosa*, with which it might easily be confounded by a cursory observer. The first obvious distinction to the naked eye, is a slightly frosted appearance, and the colour more usually brown: upon handling, the fibres readily break, and a slight friction between the finger and thumb, reduces it to powder like sand; but this arenaceous appearance is found, by the assistance of the microscope, to be a tenacious vesicular substance, possessing in some points of view, (when examined under the condensed rays of the sun, or a lamp,) a micaceous lustre.

A single specimen of this sponge in my cabinet, was originally collected for *fruticosa*, and the distinction was not immediately discovered.

Coast of Devon.

34. *Parasitica.* Texture coarse; form indefinite, determined by the body on which it creeps.

Frequent on Sertulariæ, sometimes following the course of the branches individually, which it envelopes; at other times spreading laterally, and uniting the branches together, becoming an unformed mass: the texture is rather coarse, and the

fibres fimbriated. Sometimes in larger masses at the base of Sertularia antennina, and other vesicular corallines.

Not uncommon.

35. *Fava.* Irregular, extremely porous, rather hard and brittle, appearing like a piece of old worm-eaten cork.

This sponge, though harsh to the feel, yields to the pressure of the finger-nail without elasticity: when recent, is orange-yellow, and full of gelatinous flesh, but when exposed for a time on the shore, and the fleshy parts decayed and washed out, the pores are observed to be roundish. When examined by a lens, has a slight resemblance to a honey-comb; the pores, however, are not regular in size. If taken fresh, and artificially dried, the pores are greatly obscured by the contracted gluten, and the colour becomes of a dark brown. If it has undergone a natural decomposition of the more perishable parts on the sea-shore, by the conjoined action of the water and the air, the pores are cleared, and it retains a light yellowish colour. A specimen in this state before me, is flat and broad; round the edges, (which appear to have been broken,) there are many large round openings, intersecting the smaller pores, and communicating with those on the flat surfaces. This piece is three inches long, two broad, and about half an inch thick.

Coast of Devon; not common.

36. *Plumosa.* Irregular, rather soft and tough when deprived of its gelatinous flesh, somewhat resembling compressed tow.

The texture of this sponge is not very fine, but loose, and pervious to light, not very unlike *officinalis*, but of a paler colour, and not so compressible and elastic: it is composed of small fimbriated or feather-like fibres that intersect each other, interspersed with larger pores. It has not been ascertained to what size this species grows, or to what it is naturally attached. One or two specimens only have occurred: these are of a yellowish-white colour, about three inches high, and more than two inches broad.

Coast of Devon; rare.

37. *Coriacea.* Shape indefinite, wrinkled and cavernous, not unlike a piece of burnt leather.

The fibres that constitute this sponge, are composed of very fine spiculæ, and are intersected with numerous large pores and cavities, giving the appearance of singed leather, or a piece of dark-coloured worm-eaten wood in a very decayed state. One side is rather smooth, with circular depressions or cavities. The only specimen that has occurred, is much depressed, four inches in length, and about two in breadth.

Coast of Devon.

***** ORBICULAR.

18. *Verrucosa.* Globose, and externally verrucose; internally fasciculate, with rigid asbestine radiating fibres.

Alcyonium lyncurium. Lin. Syst. p. 1295?—*Gmel.* p. 3812?

Alcyonium aurantium. *Pallas*, Zooph. p. 357?

Plate xii fig. 4, 5.

It has long been a matter of doubt, whether ome of the present *Alcyonia*, without evident tellate pores, and composed internally of asbesine spiculæ, do not in reality belong to the genus *Spongia*. Mr Ellis was favourable to this opinion. Not having the means at present of comparing all the figures given by different authors for the several orbicular species of supposed *Alyonium*, it is with considérable doubt that I have referred to *lyncurium* for *Spongia verrucosa*, hereafter described. Müller has given an orbicular pecies which he calls *Alcyonium cranium, Zool. Dan.* iii. tab. 85., and has referred to the Linnean *yncurium*. If this is truly the Linnean species, t is not in the least like what is here described; hough it is probably a *Spongia*. Müller has also figured what he considers the Linnean *Alcyonium ydonium, Zool. Dan.* iii. tab. 81.; but this is clearly an *Alcyonium*, bearing innumerable polypi;

and we cannot therefore think it is the same as the *Alcyonium cotoneum* of Pallas, which may be the Linnean *cydonium*, and is probably a *Spongia*.

With such insurmountable difficulty as that of affixing the synonyma to this, and many other subjects in this very intricate class of beings, I must solicit the indulgence of the scientific, and leave them to decide if the species here described, and accompanied with a figure, is, or is not, the *Alcyonium lyncurium* of Linnæus.

*Spongia verrucosa* is globous, of a yellowish colour, extremely verrucose, and fleshy, which becomes very hard by drying, and is of considerable gravity even in that state: the warts on the surface, are approximating, irregular in shape, and destitute of any pore: the internal part or nucleus, is composed of fasciculate fibres, connected by the animal gluten; these fill the whole internal cavity, and radiate to the centre, appearing like threads of asbestus.

The specimen from which the figure is taken, was found on the coast of Devon, and is about an inch and a quarter in its greatest diameter, for it is not quite a regular orb, but very slightly depressed; at the base, the coat is a little broken by separation from the body to which it was affixed, displaying the internal asbestine spiculæ.

89. *Pilosa.* Globous, fleshy, covered with short thick-set hair: internally, fasciculate with rigid asbestine fibres, radiating from the centre.

Plate xiii. fig. 1, 2.

This is another of the solid orbicular sponges which may possibly have been confounded with *Alcyonium lyncurium*, or *cydonium*; indeed I cannot be certain it is not the latter divested of its tomentose covering, when, by the assistance of a lens, a truly spongy surface is observable. In this imperfect state, it might conform to *Subrotundum spongiosum flavum læve*; but I dare not venture on synonyma. The discordances of zoophytists are so great, and the synonymes so numerous, that it is utterly impossible to make out the species; and we are constrained to form new species, where characters do not accord. This is nearly allied to the preceding *Spongia verrucosa*, which in some degree may be likened to *Alcyonium lyncurium*, because it is verrucose. The present subject, *Spongia pilosa*, was taken by Mr Fleming in Zetland, who favoured me with a specimen. I shall therefore only give a description of it, and if any thing should be omitted in its usual characters, it is to be hoped, that, we shall receive from that naturalist any additional information.

The specimen of Spongia pilosa before me, has the pilosity removed from one side, shewing the

spongy reticulated covering, but which, in th other part, is perfectly concealed by a thick se and very fine cinereous hair. Like *Spongia verru cosa*, it is rendered hard by the drying of a larg portion of animal gluten that forms the exterio part or coat, and which consequently gives rigi dity to the spongy surface. The hairs which co ver the surface when perfect, are in fact continua tions of those long asbestine-like spiculæ that fi the whole internal cavity: when the coating o fleshy part that surrounds these spiculæ is cut, anc the sponge is pulled asunder, the fibres are drawi out their full length, and as the fleshy part con tracts in drying, they derive an inclination t twist, and appear so numerous and prominent, a if they could not have been contained in th sphere. But to explain the subject more full a figure accompanies this, of the natural siz as well as the appearance of the surface whe magnified.

Diameter about three quarters of an inch.

*Ind*

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## VII. *Mineralogical Description of Tinto.*

By Dr Macknight.

*(Read 11th April 1812.)*

Tinto, the subject of the following paper, is a mountain of Lanarkshire, which rises to the height of about 1700 feet above the flat, to the east of its base, and 2300 from the level of the sea *. Standing distinct from the mountain-ranges which appear on the south and east, and from which it is isolated by the intervening course of the Clyde, it forms a conspicuous and magnificent object, as viewed from the adjacent lower country, on the north and west.

The name of *Tinto*, which signifies, it is said, "the Hill of Fire," seems to imply, that in ruder

* This mode of estimating the height of Tinto, may probably reconcile the very different statements of it, which have been given. Jameson's Geognosy, p. 315.

ages, its lofty summit had been regarded as an object of veneration by the surrounding inhabitants, perhaps the scene of some particular superstition; or it may have been employed in time of war, as a signal or alarm-post for the neighbouring country. However this may be, the cairn or heap of loose stones, which forms the highest point of the mountain, and by some is considered as having originally been a Druidical temple, has probably been the gradual accumulation of many ages.

As pasture-ground, the base and ascent of this mountain on every side, must be extremely valuable to the proprietors. But that circumstance lessens its interest, as a subject for either the painter or the mineralogist. The general form of its outline in a distant view, is beautiful and striking; but its minute features, compared with those of alpine regions, are smooth and uninteresting. Tinto presents no rugged peaks, serrated ridges, or bold precipitous fronts of rock; it has few traits of alpine rudeness, and is rather a grand than a picturesque object. Hence its facilities of mineralogical examination, are so imperfect, that on being conducted by the usual path to the summit, for the first time, in the whole of an ascent, extending nearly to three miles, I was unable to discover a single trace of rock *in situ*; so completely is the surface enveloped in soil and debris. Subsequent investigation, however, proved more fortunate; and although by no means

entirely satisfactory, from the smallness and infrequency of the rocky masses which remain uncovered, was such, I trust, as has enabled me to ascertain the formation of the mountain, and to convey a tolerably accurate conception of its structure.

From these remarks, it may in general be presumed, that Tinto is of *secondary* formation. The eastern extremity of its base, forms the lowest boundary of the mountain-valley along which the Clyde flows. From this level, the base springs with considerable steepness, to the height of about 400 feet, where we arrive at the first stage or rounded back: and after ascending another height of perhaps 500 feet, a second platform, with an inclination towards the west, brings us to the acclivity, from which the elevation proceeds to the summit without interruption; exhibiting the elegant conical or rather ellipsoidal figure of this noted mountain. From the foot of the western acclivity, Tinto stretches into a long and apparently unbroken ridge, which penetrates the country for several miles to the south-west.

The sketch which accompanies this paper, though very imperfect, will enable the Society to follow the description I am now to give.

Tinto, then, in the language of Werner, may be described as a flœtz mountain superincumbent, I conjecture, on grey-wacke. For, of this rock, which is known to extend like a zone or belt across the country, from St Abb's Head on the

north-east, to the extremity of Scotland on the south-west, the great mass of the Tweddale hills in the vicinity of Tinto, seems to be composed.

The substance which lies immediately over it, in the body of the mountain we are describing, is a conglomerate, having a basis of clay, with a dark greyish colour, and somewhat resembling an intimately mixed greenstone. The fragments it contains, are from the size of a grain, to that of large balls; and consist of rounded or water-worn masses of transition rocks, such as grey-wacke, grey-wacke-slate, iron-clay, and common flint-slate, with veins of quartz. There are also fragments or nodules of quartz, mica, felspar, splintery hornstone, and felspar passing into conchoidal hornstone.

This conglomerate, I conceive, forms the base of Tinto; as it is found, either *in situ*, or in the form of debris, at various places around the lower part of the hill, particularly on the south side, a little above the old ruin opposite to Lamington. Where the rock becomes finer grained, as on the north side, it exhibits scales of mica, and both in appearance and in composition, bears a strong resemblance in some places to grey-wacke, and in others, to those portions of the old red sandstone which are conjectured to alternate with the newer members of the transition series. It is therefore probable, that, were the base of the mountain laid bare, we should discover indications of what is

here supposed. The colour of the rock to which I allude, is most generally greenish-grey.

Over the conglomerate, which crops out at different heights along the base on the south side, masses of claystone, greenstone, and greenstone passing into clinkstone and porphyry-slate, successively appear, till we arrive at the summit of the mountain, which is found to consist of compact felspar, and felspar-porphyry, with crystals of quartz, mica, felspar, and hornblende. The felspar rocks also contain thin layers or beds of reddish-coloured quartz.

That these substances, composing the great body of Tinto, are disposed in beds, is sufficiently probable; but, it would be more than is warranted by my observation, were I directly to assert the fact, having been unable to do more than ascertain their separate existence and relative position in the order mentioned. So far as I could judge, if the felspar is in beds, they are almost vertical, and run nearly in the direction of north-east, and south-west.

The nature and characters of the felspar, which in general may be described as slaty-compact, are distinctly shewn by the cropping to be seen about half a mile below the summit, towards the south-west, where the surface over a great extent exhibits this variety of the rock, both *in situ* and in detached masses of all sizes, decomposing in plates or layers of various thickness, from a quarter of an inch to half a foot.

At the foot of the mountain in this direction, a quarry has been opened, in which I found it impossible to procure a fresh specimen. The rock seems to be a fine-grained sandstone, not unlike grey-wacke-slate. There is also a portion of compact greenstone.

Returning eastward, on the south side, we come to a stream nearly opposite to Wiston Hill, in the course of which, about half way down the declivity of Tinto, compact greenstone, and a rock intermediate betwixt greenstone and porphyry-slate or clinkstone, appeared *in situ*, a little above the conglomerate, over which they lie. I found here a vein of felspar, evidently filled from the superincumbent formation.

The next object of any importance, which presents itself in the same direction, is the Pap-Cragg. Here the substances just mentioned, ascend to a height not inferior to that of the slaty compact felspar already described on the south-west face of the acclivity; but I could not discover the line of their junction with the felspar rock. The Pap-Cragg is an abrupt conspicuous front of some size and extent, containing greenstone, and greenstone with specks of earthy or mealy zeolite, which give it the appearance of an exact porphyry-slate. Among the debris below the Cragg, fragments of clinkstone occur abundantly.

A little farther towards the east, and at an elevation somewhat lower, the conglomerate appears at its greatest height; and from this point, seems

to stretch beneath a gradually descending line to the eastern extremity of the base. At this extremity, and at a small height above the level ground, we observe the commencement of the claystone and felspar formation, which lies over the conglomerate and greenstone rocks, and by means of the reddish-coloured debris, above the line now mentioned, may be traced westward, along the brow and rounded back, to the summit of the mountain, forming the whole of its upper part. The claystone passes into felspar, and occasionally presents dendritic delineations and veins of heavy-spar. I am inclined to think, that betwixt the conglomerate and the claystone, there is all along interposed a mass or bed of the greenstone substance which appears in the Pap-Cragg, and which, here, might be supposed as in fact nothing else than the base of the conglomerate unmixed with the coarser fragments that occur towards the lower part of the base: but I had no opportunity of verifying the conjecture.

On the declivity of Tinto, towards the north and north-west, similar substances occur: but the felspar formation descends considerably lower down than under the south side of the summit. The body of the mountain on the north side, is indented by three deep re-entering angles, and presents two vast projecting shoulders, one facing the north, the other inclining to north-west. These shoulders are evidently covered with the porphyry formation which composes the summit, and ex-

tends over the eastern acclivity and ridge of the mountain; but underneath it, the same rocks, claystone, porphyry-slate, and conglomerate, with the addition of the sandstone resembling grey-wacke, occur in the same relative position, as on the opposite side.

In particular beds of the north-west re-entering angle, the claystone assumes a brecciated appearance. Sandstone occurs, which appears to be a mixture of claystone and quartz. The overlying slaty-felspar, contains minute portions of a crystallized matter, like vesuvian or garnet. In other specimens, the felspar inclines to hornstone. The whitish debris of the felspar and claystone, is particularly conspicuous, in the re-entering angle that faces the north under the summit, where it covers the whole of the east side, almost to the bottom of the ascent.

Along the Kirk-Burn, which runs eastward, from the great north-east re-entering angle, the usual phenomena of this mountain are to be observed. The felspar and claystone may be found *in situ*, at a lower elevation than elsewhere, and in the vicinity of the conglomerate and sandstone, which here form considerable heights to the north of the rivulet. Among the debris of this stream, I met with a beautiful specimen of the Petrosilex of the Swedish mineralogists; it is porphyritic compact felspar, approaching to hornstone, with crystals of hornblende, and a fracture compounded of the splintery and conchoidal.

With regard to the environs of Tinto, the rising ground called the Castle Hill, about a mile from the foot of the mountain, on the south-east, consists, as far as I could ascertain, from the minute croppings it affords, of greenstone, which, I presume, trends eastward to a considerable distance, the quarry near the church of Symington having uncovered a bed of that substance. This greenstone is probably newer than the grey-wacke, which I suppose lies beneath the base of Tinto.

On the Castle Hill, I found a variety of fragments and rolled masses, which serve to illustrate the nature of the rocks in this district: grey-wacke, common flinty-slate, flinty-slate with veins of quartz, felspar-porphyry with a violet hue, and specks of a greenish matter somewhat resembling the newly designated Pimelite of Karsten; also sandstone with casts, and a very compact brecciated stone, having a basis approaching to greenstone, and including fragments of quartz, iron-clay and jasper.

Amygdaloid, another member of the flœtz class, is the rock which forms the bed of the river, at the new bridge erected over the Clyde, on the road to Biggar. Its base is wacke, and it is surrounded by beds of fine-grained and compact sandstone, coloured with green earth. The vesicles are filled with nodules of calcedony, coated with green earth, and having quartz in the

centre. Other specimens contain quartz passing into flint, and amygdaloidal portions of steatite. Calcspar, too, is an abundant ingredient of this rock. Where it joins the sandstone, there is a mixture of both substances,—a frequent appearance in such cases. Some miles to the westward of Symington, limestone occurs; but I did not examine it, or procure specimens.

On the other hand, the sandstone of which the whole inferior districts of Lanarkshire are composed, and which may be traced for so many miles along the course of the river, I consider as belonging to the same formation with the sandstone-conglomerate at the base of Tinto; and as corresponding to what is called in the Wernerian system, the Old Red Sandstone. It is to the waste of this rock that we owe the splendid scenery of Cora-Lin, and the other celebrated Falls of the Clyde, which have long attracted the notice and admiration of travellers. In its descent to the lower country, it appears to be still accompanied with portions of the same substances which overlie it in the body of Tinto; as porphyry-slate and felspar-porphyry have been found near the Cora-Lin. Below the Fall of Stonebyres, the rock assumes a coarser texture; and, if I am rightly informed, again exhibits a conglomerate, similar to that of Tinto, by including masses of transition-slate, splintery hornstone, quartz, jasper, and flinty-slate.

In concluding the delineation of Tinto and its neighbourhood, I may remark, that the relative disposition of the several rocks composing its mass, corresponds with sufficient exactness to the geognostic description of a flœtz mountain. The conglomerate every where occupies the lowest place, and is covered, in a manner perfectly conformable to the most natural idea of deposition, with greenstone, claystone, and felspar, all evidently of flœtz formation, and assuming a finer and more crystalline texture as we ascend.

This occurrence of claystone and felspar, in a position corresponding to what is found in the Eildon Hills, the Pentlands, the Ochils, Papa Stour, around Dundee, and in other places, appears to favour the hypothesis of a particular overlying flœtz formation, in which these substances are prevailing ingredients, extending over a considerable portion of the lower country of Scotland. I am informed, that the districts adjoining to Hallé in Westphalia, are of a similar structure and description. The conglomerate of the Grampians, seems to have been formed from the debris of older rocks.

It is also worthy of observation, that the characters and relative position of the conglomerate on which Tinto rests, considered in its connection already described, with grey-wacke on the one hand, and the older sandstone on the other, seem to furnish an illustration of a very important fact;

namely, that there are alternations between the oldest members of the Floetz rocks, and the newest portions of the Transition series,—corresponding to a similar relation, which has been observed between the newest Primitive and the oldest Transition rocks. We thus learn, that the newest members, for example, of the primitive, do not immediately cease, or at once give place entirely to the transition rocks; but that, most frequently, before these are found completely to prevail in the order of succession, alternations, as now mentioned, take place. And the remark may be generalized respecting the junctions of all the successive classes in the system, down to those of the latest periods.

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The account I have given of the structure of Tinto, approaches perhaps as near the truth, as the geognostic inspection permitted by the state of its surface, authorises. Future investigation will no doubt, correct or improve it. I cannot hope, that it will be found to contain much that is particularly interesting to the mineralogist. It records no occurrence of rare or precious minerals,—no irregular junctions, dislocations, or extraordinary phenomena of stratification, to raise the astonishment

of the observer, or exercise the philosopher's talent of explanation. But he who exhibits a faithful picture of what he sees in nature undescribed before, contributes something to the progress of knowledge; and, without pretending to assert, that the mineralogists of the German school have yet possessed themselves of all the domains to which they lay claim in the mineral kingdom, we may safely presume, that, at least, they are fairly on the way to accomplish at length a complete system of accurate description, without which, it is vain to expect, that geology will ever ascend beyond the rank of ingenious theory, or become a science.

I have only to add, that if this mountain shall again be surveyed mineralogically, the observer need hardly promise himself, that the geognostic result of his examination of the ground over which he passes, will prove entirely to his satisfaction. At the same time, if he is fortunate in weather, and has a relish for the beauties of nature, he will be gratified in another way, by attending to the prospect seen from Tinto, which spreads before the eye of taste, an uncommon variety of agreeable objects, and a great extent of interesting scenery.

The expanse of country which it embraces, appears unbounded on the west side; but towards the north, it is terminated by the majestic Ben-Lomond, and the lofty ranges of the Highlands,

crowding irregularly into view, in a manner extremely picturesque. In the opposite direction of the south-east, the prominent features of this view, are the bold undulating mountain-lines, the finely grouped masses, and the alternate swells and deep hollows of the Tweddale hills; amongst which, the most remarkable is Culter-Fell, distinguished as the rival of Tinto itself, in size and height. These magnificent objects, presenting themselves on the one hand, form an admirable and striking contrast to the delightful appearance, on the other hand, of the level country that stretches along the banks of the Clyde. What adds to the effect, and can hardly fail to strike the eye at first sight,—the different places where the river displays its shining surface, seem, as if disposed with the happiest skill, for producing the impression of the picturesque.

This noble stream, which shews in its course so many charms of natural scenery, and whose fine sweeps through the mountain-valley, and lower districts of Lanarkshire, are so great an embellishment of the whole prospect, may in truth be said to carry along with it, beauty and fertility from its very source. It is equally pleasing and unexpected, to find at the height of 600 feet above the level of the sea, a tract of land, so rich in soil, so well cultivated, and so extensively clothed with plantations, as the district spreading around the foot of the mountain, from Hyndford-house to

Symington and Culter, and up the river to a considerable distance. The effect of the landskip is completed by the number of villas, and other marks of population and comfort, which every where appear in the vicinity of the Clyde.—There are few elevations in the United Kingdom, where a finer assemblage of the grand, and the beautiful in nature, may be contemplated, than from Tinto.

## VIII. *Short Account of the Rocks which occur in the Neighbourhood of Dundee.*

By the Rev. John Fleming, Flisk.

(In a Letter to Professor Jameson.)

*(Read 22d February 1812.)*

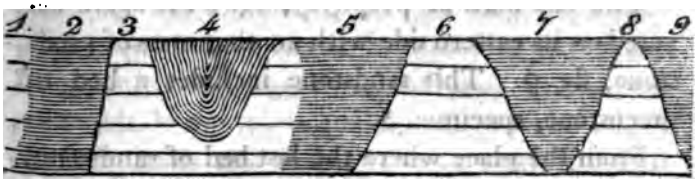
Sir,

In answer to the inquiries which you made some time ago regarding the position of the claystone and porphyritic rocks in the neighbourhood of Dundee, I send you the following remarks, which I made, while walking along the shore of the Tay, from Invergowrie eastward to the town of Dundee.

In the bay at the old church of Invergowrie, the shore is level, and composed of gravel; but, on the east side of the bay, the rocks of sandstone form a steep precipice. This precipice is about thirty feet high, and continues nearly to Dundee,

of the same height, independent of the variety of rocks, forming a steep bank on the north side of the river Tay. In this bank, there are some important sections of the strata displayed, which I propose to describe.

Where the sandstone begins at the east side of the bay, it occurs in thin strata dipping to the north-west, at an angle of about 15°. This sandstone soon disappears, when a mass of porphyry forms the bank. Its western extremity is but indistinctly displayed; its eastern extremity is covered with sandstone. This porphyry has a slaty structure in the great, is composed of a basis of compact felspar, and contains numerous crystals of common felspar, and a little basaltic hornblende. The sandstone soon gives place to the porphyry which rises below it, and forms the precipice for a considerable distance. East from the Boothe, there is a mass of sandstone interposed, as represented at fig. 2.




The porphyry, fig. 1., is disposed in strata about four feet in thickness. It is traversed by a vein containing calc-spar, brown-spar, and sparry-iron-stone,—minerals which are nearly related, both in their oryctognostic and geognostic characters. The

line of junction between fig. 1. and 2. is indistinct. The other extremity of this mass of sandstone, rests upon the porphyry, fig. 3. In this last-mentioned porphyry, fig. 3., there is a basin-shaped cavity, fig. 4. which has been filled up with sandstone. The strata of sandstone are parallel with the inclined edges of the cavity. The same bed of porphyry farther eastward seems to rest on the sandstone, fig. 5.; but the appearances are indistinct.

The sandstone, fig. 5., rests upon the mass of porphyry, fig. 6. This last porphyry varies in colour and composition in different portions of the bed. Some portions are of a grey colour, with imperfectly formed crystals of earthy felspar, while other portions are reddish-brown, and contain besides the felspar a considerable number of crystals of hornblende. This porphyry soon gives way to another deposition of sandstone, fig. 7., both extremities of which rest upon porphyry, and exhibit an instance of an *upfilling*.

The last mass of porphyry, fig. 8., is again covered on its eastern side with another mass of sandstone, fig. 9. This sandstone includes a bed of greenstone, specimen 5.

From the place where the last bed of sandstone, fig. 9. commences, to the place called the Crescent, the mineral appearances are but imperfectly disclosed, as may be seen in the figure, which, with the specimens, will convey all the information which I could obtain.

S.

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|---|---|---|---|---|
| | | | | Sandstone. |
| Sp. 5. | | | Sp. 12. | |
| | Sp. 6. | Sp. 7. | | |

The specimen No. 5. *, is greenstone; its fragments sound like clinkstone. Specimen 6., is a greenstone abounding in felspar, in a state of decomposition. Specimen 7., is a soft claystone-porphyry. Specimen 12., is a claystone-porphyry, with minute grains of sand.

Opposite the Crescent, the rocks disappear, and the shore becomes level. Here, however, a rock of greenstone appears rising among the rocks of the shore. It abounds with hornblende, and is in some places amygdaloidal. Specimen 8. is from it.

Passing this mass of greenstone, the relations of which I could not ascertain, a bed of claystone, specimen 11., equally imperfectly exposed, makes its appearance on the shore. After passing this claystone, rocks of greenstone now form the shore, and continue without interruption to the town of Dundee. Specimen 10., is from this bed of greenstone. In the neighbourhood of the town, the greenstone seems to pass into clinkstone,—a

* The numbers refer to the specimens presented to the Wernerian Society, and deposited in their collection.

transition, which, I think, I have observed in other places.

From the preceding description, it will appear, that many changes have taken place in the position of these beds of sandstone and claystone since the period of their formation. But, of the cause of these dislocations or slips, we are entirely ignorant. The situation of the strata of sandstone in the basin-shaped cavity of the porphyry, makes us acquainted with a fact in the history of stratification, of the greatest importance. The abettors of the vulcanic hypothesis contend, that all the strata of rocks were originally deposited in a horizontal position. The fact before us, is in opposition to such an opinion. The strata in the bed of porphyry are nearly horizontal, whereas the strata of sandstone are highly inclined, being parallel with the sloping sides of the basin. If we suppose one of the sides of this cavity removed, and the inclined strata on the other side of the cavity left behind, a superficial observer would be ready to conclude, from such partial appearances, that these inclined strata had been moved into their present angular position by an ascending movement of the inferior bed of porphyry. Instances frequently occur to every practical mineralogist, where highly inclined strata thus rest upon the inequalities of the fundamental rock, which, to all appearance, has never been moved. The disciples of the German school embrace the opinion, that " in

strata composed of chemical precipitates, all the variety of inclination depends on the inequality of the bottom;" and in this they are confirmed, not so much by attending to appearances in small portions of rocks, such as here described, as by an examination of the structure of mountain masses.

These few remarks certainly lead to little that is precise or important in the history of the strata, now described. They indicate, however, the intimate relation which subsists between the sandstone and the claystone. This relation, I had previously ascertained in my examination of the Island of Papa Stour *; and the observations which I have recently made on the south bank of the Tay, tend still further to confirm and illustrate it. At Fliskwood, directly opposite to the north bank of the river, where the appearances detailed above are exhibited, the sandstone covers the claystone. Here the sandstone rests upon very soft clay-porphyry, which passes into claystone. This claystone at last becomes more compact, assumes the amygdaloidal structure, and then becomes connected with compact felspar.

These appearances seem to indicate the existence of a family of floetz-rocks, consisting principally of claystone, felspar, and sandstone, the relations of which are but imperfectly understood.

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* Wernerian Memoirs, vol. i. p. 162.

Should these remarks appear to you sufficiently interesting, I beg of you to communicate them to the Wernerian Natural History Society, with my best wishes for its prosperity. I am, &c.

## X. *Observations on the Mineralogy of the Neighbourhood of St Andrew's in Fife.*

By the Rev. John Fleming, Flisk.

*(Read 5th February 1813.)*

The county of Fife contains two very distinct formations of rocks, which belong to the Flœtz class. The country to the north of the river Eden, which runs through Fife in a direction of west to east, contains strata which are connected with the Old Red Sandstone, and are geographically related to the beds of sandstone, porphyry and greenstone, which I formerly described to this Society, as extending along the shore of the Tay, from Dundee westward, on the north bank of the river. The southern portion of Fifeshire, contains strata exclusively belonging to the Independent Coal Formation, and forms an interesting part of the coal-

field which occupies the river district of the Forth. An overlying formation of Trap rocks, in the form of conical hills, or irregular patches, covers the rocks belonging to these two formations, and may be observed to the south as well as to the north of the Eden. The city of St Andrew's is situated on the north-eastern extremity of the district occupied by the strata belonging to the independent coal formation. The rocks which occur in the neighbourhood of the city, present a few circumstances in their history, which deserve to be noticed. These I shall briefly detail.

In conformity with the plan pursued by the disciples of the celebrated Werner, I shall state my observations on the rocks which are considered the oldest, and afterwards notice those which appear to have been deposited at a more recent period. The rocks, therefore, which fall to be considered first, are such as belong to the Independent Coal Formation.

The strata in the vicinity of St Andrew's, preserve no regular line of bearing. In a few instances, they are horizontal, but in general they present basin-shaped or saddle-shaped undulations; the strata at the margins of these bendings, incline to the horizon at various angles. The rocks are chiefly Sandstone, Coal, Slate-clay, and Clay-ironstone.

The individual beds are subject to great variation in depth. The beds of sandstone in particu-

lar, sometimes swell out to a considerable thickness, and farther on in their line of bearing, almost disappear. At a place called the Witch-Lake, a bed of sandstone rests upon a horizontal bed of slate-clay. The surface of the bed of sandstone suddenly swells out into a knob, and the slate-clay deposited over this inequality, is seen to rise at a considerable angle on each side in opposite directions, meeting at the top. The inspection of this appearance, will point out the cause of those bendings in the strata to the eastward of the city, and convince the observer, that no other circumstance is required to produce those wavings, than an uneven surface of the inferior beds, and that these inequalities of the surface have been produced by the unequal attraction exerted by the beds already formed, to the matter depositing over them.

## I. *Sandstone.*

The sandstone occurs in thick beds, which are distinctly stratified. The grains of quartz are sometimes very minute, and the sandstone is fine-grained. In a few instances, the grains of quartz are large, and the sandstone approaches in characters to conglomerate. The cement of all the sandstones in the vicinity of the city, is easily acted upon by the atmosphere, and hence they are

very liable to decomposition. I observed that those sandstones which contained much mineralized vegetable matter, were the most easily decomposed, and were frequently so friable, that they could be crumbled down between the fingers. The sandstone occasionally contains a little mica, and likewise mineral charcoal, and not unfrequently small globular pieces of iron-pyrites.

## II. *Coal.*

A few beds of coal occur in the beds of sandstone. These are, however, of trifling importance, very seldom more than a few inches, and never exceeding a foot in thickness. They are principally slate-coal, containing numerous petrifactions of reeds, flattened and compressed. Thin layers of pitch-coal also occur, both in the slate-coal, and also in the sandstone. In one of the largest beds of coal, I observed globular concretions of sandstone, having the thin layers of coal surrounding them on all sides.

## III. *Slate-Clay.*

This rock occurs in beds of various thickness and of every degree of hardness and density.

passes distinctly into sandstone, by acquiring small portions of mica and quartz. It likewise passes into limestone and bituminous shale. It includes thin layers of sandstone, and often contains vegetable impressions.

I think it proper in this place to mention a fact not generally known, That slate-clay forms a fertilizing manure to sandy soils, by supplying the requisite portion of aluminous earth. In the neighbourhood of Kirkcaldy, there are several fields of sandy soil which rest upon sandstone. To these fields, slate-clay and bituminous shale have been applied as manure, and with success: they were, previous to this application, unproductive; they now yield good crops of grain and grass. To the west of St Andrew's, there are extensive tracts of soil, principally composed of sand. Were the slate-clay, so abundant among the rocks in the neighbourhood of the city, spread upon these grounds, the most beneficial effects would result from the application. The ground would become firmer, the soil more retentive of moisture, and better able to resist the drought of summer. Ignorance and prejudice may prevent some from following the example of the farmers in the neighbourhood of Kirkcaldy; but I have no hesitation in asserting, that its imitation in many places of the coal districts of Scotland, where such soils and such rocks abound, would greatly contribute to increase the food of man and beast.

## IV. *Clay-Ironstone.*

The common claystone occurs in beds from an inch to upwards of a foot in thickness. It contains a few vegetable impressions. The kidney-shaped sub-species, is likewise common. Both of these are included in beds of slate-clay. They are sometimes collected and sent to the Carron Iron-works; but the quantity so procured, is trifling.

In this place, I may take the liberty of observing, that the closet mineralogist may indulge in hypothetical speculations regarding the formation of minerals; but such conjectures will never aid the cause of science, or make us acquainted with the secrets of nature. I have no doubt, but that Dr Hutton, upon examining a specimen of the Septarium iron-ore, was gratified with the idea of having found a convincing proof of the igneous consolidation of fossils, and regarded his explanation of the singular structure of that mineral as the only one which approached the truth. But we hesitate not to say, that had that ingenious philosopher ever attended to the natural history of the Septarium,—had he ever examined it in its clayey bed,—completely surrounded with matter

which presented no marks of igneous influence,—he could not have avoided drawing the conclusion, that since the bed of slate-clay, which contains the septarium, presented no marks of the action of heat, the septarium contained had never been exposed to its influence.

Having thus shortly given an account of the rocks belonging to the independant coal formation which occur in the neighbourhood of St Andrew's, our attention will next be directed to a small portion of the Newest Flœtz-trap formation which covers these rocks.

In many places in Fife, overlying rocks of Basalt, Clinkstone, Felspar, Porphyry-slate, and Claystone, occur resting on the rocks of the old red sandstone, and the rocks of the coal formation. But it rarely happens that distinct sections of these rocks can be found, or the relations which they bear to one another ascertained. On the sea-shore, to the eastward of St Andrew's, a portion of the newest flœtz-trap occurs in such a situation that its geognostic characters can be ascertained with precision.

This formation rests upon beds of sandstone, and the other rocks described above. It extends about 300 yards along the shore, and is connected with a more extensive deposition of the same kind, which stretches inland, but whose history

cannot be easily investigated on account of the thick continuous bed of soil with which it is covered.

## V. *Trap-Tuff.*

The principal rock of this formation is trap-tuff, similar in composition to the rock of the same kind which occurs in Arthur's Seat. It contains globular pieces of quartz and granite, which have been water-worn;—likewise fragments of grey-wacke, flœtz-sandstone, and limestone containing petrifactions of entrochi. Small pieces of augite and felspar are likewise contained in it. The inclosed fragments of the older rocks are sometimes of considerable size, measuring two or three entire feet.

It generally happens, that the fragments of the oldest rocks, when observed imbedded in the newer formations, are much rounded and water-worn: Whereas the fragments of the newer rocks, are rather angular, and seem to have suffered less from attrition:—a circumstance which points out with considerable precision the relative antiquity of rocks, and is entitled to a more careful examination than has hitherto been bestowed upon it.

The most curious circumstance which attracted my notice, in examining this bed of tuff, was the rock, which is well known in the neighbourhood

of St Andrew's by the name of the Rock and Spindle, and from which it is distant about a mile and a half.

This rock is about forty feet in height. Towards the base, there is a spherical concretion of basalt, in the form of five or six-sided lengthened pyramids meeting at the apex, giving to the mass a stellate appearance. The mass is likewise divided into concentric layers. The basalt contains crystals of augite, with olivine, and glassy-felspar. This concretion of basalt is surrounded with the tuff, into which it gradually passes; and must have been completely enveloped by it, previous to its partial wasting away by the action of the sea and atmosphere. It may be mentioned in this place, that the regular basaltic columns at the Ely, are a portion of a spherical concretion contained in trap-tuff. Here the concretion is only about ten feet in diameter: at the Ely it is several hundred feet.

In other parts of the tuff, small masses of amygdaloid and basalt occur, leading directly to the conclusion, that the bed is partly a mechanical, and partly a chemical deposit, since these rocks imperceptibly pass into one another.

If the regular forms of basalt induced Dr Hutton to conclude, that they furnished proofs of the action of a central heat, he would have found considerable difficulty in applying his heat to these

inclosed masses of basalt, without fusing the bed of tuff which surrounds them.

He who has the boldness to build a theory of the earth, without a knowledge of the natural history of rocks, will daily meet with facts to puzzle and mortify him.

## X. *Meteorological Observations on a Greenland Voyage in the ship Resolution, of Whitby, in* 1811.

By William Scoresby *jun.* M. W. S.

*(Read 22d February* 1812.*)*

In the following Table, those Latitudes and Longitudes to which an asterisk is annexed, were ascertained by celestial observations; consequently they may be considered as correct.

The column of Winds, is according to the magnetic meridian.

*Meteorological*

## *Meteorological Observations on a*

| Dates. | Latitude. | Longitude. | Therm. No. of Obs. | Therm. Mean. | Bar. at Noon. | Winds. | Strength o |
|---|---|---|---|---|---|---|---|
| | | | | | In. | | |
| March 11 | 56°26′ N. | 0°53′ W. | 1 | 47° | 30 35 | W.erly, to N E | Light or |
| 12 | 57 16* | 0 40 W. | 3 | 49⅔ | 30 53 | N W.erly | Moderate |
| 13 | 58 13* | 0 56 W. | 3 | 50 | 30 58 | Do. or calm | Light airs |
| 14 | 58 46 | 0 53 | 2 | 42½ | 30 59 | Calm or S.erly | To fresh |
| 15 | 60 4 | 0 46 W. | 2 | 43 | 30 43 | S W.erly | Strong |
| 16 | 60 9 | 1 8 W. | 1 | 51 | 30 33 | Ditto | Moderate |
| 17 | Brassa | Sound. | 2 | 48 | 30 04 | S W | Ditto |
| 18 | | | 2 | 47 | 29 83 | S W | Fresh gales |
| 19 | Ditto | Ditto | 2 | 47½ | 29 93 | to W | Do. or light |
| 20 | | | 2 | 45½ | 29 73 | to N W.erly | Strong gales |
| 21 | Ditto | Ditto | 3 | 44⅔ | 29 88 | Do. and W.erly | Do. to mod. |
| 22 | Ditto | Ditto | 2 | 50 | 29 99 | N W.erly | Fresh gales |
| 23 | | | 2 | 48⅓ | 30 21 | Ditto | Moderate |
| 24 | 60 20 | 0 38 W. | 3 | 47⅔ | 30 29 | W S W | Fresh gales |
| 25 | 62 51* | 0 46 W. | 3 | 48⅔ | 30 06 | S W | Do. to fresh |
| 26 | 65 34* | 2 9 W.* | 3 | 43⅓ | 29 42 | S W.erly | Strong or |
| 27 | 66 56 | 1 28 W. | 3 | 24⅓ | 29 29*a*<br>29 64*b* | Ditto to N E | Do. to fresh |
| 28 | 66 52* | 1 45 W. | 3 | 19 | 30 43 | N to W | Calm to |
| 29 | 67 0 | 2 57 W. | 3 | 22 | 30 31 | N and variable | Do. to fresh |
| 30 | 68 17* | 3 48 W. | 3 | 17⅔ | 30 37 | E calm | Do. or fresh |
| April 31 | 68 30* | 5 02 W.* | 2 | 15½ | 30 26 | N E to N N W | Fresh breezes |
| 1 | 69 41* | 3 31 W. | 3 | 16⅓ | 30 00 | to N E | Ditto |
| 2 | 69 40 | 1 11 E. | 3 | 19⅓ | 30 24 | E.erly variable | Moderate |
| 3 | 70 22* | 3 23 E. | 3 | 28⅔ | 29 70 | S W to N W | Fresh gales |
| 4 | 70 33* | 5 4 E. | 3 | 27⅔ | 29 84 | to N | To fresh |
| 5 | 70 49 | 7 15 E. | 3 | 11⅔ | 29 88 | N variable | Fresh gales |
| 6 | 71 25 | 10 53 E. | 3 | 18 | 29 50 | to N W & E S E | To stormy |
| 7 | 71 29 | 10 39 E. | 3 | 28 | 29 50 | E S E to E N E | Violent gale |
| 8 | 70 56 | 10 30 E. | 3 | 28⅓ | 29 50 | E N E | Do. squally |
| 9 | 70 25* | 8 15 E. | 3 | 19 | 29 89 | Do. to N N E | Do. to stormy |
| 10 | 70 32* | 6 58 E. | 3 | 10⅓ | 30 10 | N E.rly | Fresh or |
| 11 | 70 44 | 6 26 E. | 3 | 21⅓ | 30 26 | N E to E N E | Ditto |
| 12 | 70 52* | 6 00 E. | 3 | 26 | 30 24 | N E.rly | Ditto |
| 13 | 70 18* | 8 57 E. | 3 | 27⅔ | 30 14 | to N W, variable | Fresh breeze |
| 14 | 70 52* | 8 59 E. | 3 | 28⅓ | 30 23 | Very variable | Strong gales |
| 15 | 72 36* | 13 30 E. | 3 | 30 | 30 23 | S.erly, do. | Fresh gales |
| 16 | 74 31 | 16 32 E. | 3 | 35⅓ | 29 82 | S W to W | Do. to strong |
| 17 | 75 34 | 15 4 E. | 3 | 33 | 29 82 | W to S W | Fresh gales |
| 18 | 75 34 | 13 46 E. | 3 | 31½ | 29 66 | to W N W | Strong gales |
| 19 | 75 59 | 12 50 E. | 3 | 26⅓ | 30 12 | to calm, S W | Fresh gales, |
| 20 | 76 21* | 12 0 E. | 3 | 10⅔ | 30 12 | W.erly, N E.rly | Fresh breeze |

*a* 10 Am. 29 29. *b* Noon, 29 64.

## *Greenland Voyage*, 1811.

| Weather, &c. Aqueous Meteors. | Of the Clouds. | | Birds, &c. seen. |
|---|---|---|---|
| | Time. | Modifications. | |
| ne weather, hazy | Morng. | Cirro-stratus. | Young gulls. |
| ning cloudy, noon clear | 10 Am. | Cirro-stratus. | Ditto and teistics. |
| ne clear weather | 6 Am. | Cirro-cumulus, &c. | Young gulls. |
| ing weather | | Cirro-cumulus, &c. | A land bird, and ditto. |
| ll cloudy weather | 3 Pm. | Cirro-stratus. | Gulls and small birds. |
| ne weather | 2 Pm. | Cirro-stratus. | Ditto. |
| tto | Am. | Cirro-stratus, &c. | Ditto, &c. &c. |
| , some rain | Am. | Cirrus, &c. | Ditto. |
| ne weather | Noon. | Cirrus. | Ditto. |
| owers, hail or rain | | Cirro-cumulus, &c. | Ditto, wild ducks. |
| , rain or sleet | | Cirrus, &c. | Ditto, ditto. |
| , and hail | Noon. | Cirrus, &c. | Ditto, ditto. |
| ish do. | Noon. | Cirro-cumulus, &c. | Ditto. |
| rming fine weather | 5 Pm. | Cirro-cumulus, &c. | Young gulls. |
| tto | Morng. | Stratus. | Do. fulmars, looms, &c. |
| ny weather | | Stratus, &c. | Ditto, ditto, and land-bird. |
| owers, snow | All day | Nimbus. | Many fulmars, gulls, &c. |
| tto, aurora borealis | | Nimbus, cumulus. | Ditto. |
| ish snow | Am. | Nimbus. | Ditto. |
| it, aurora borealis | | | Fin-whales, fulmars. |
| ir weather, ditto | Am. | Cumulus. | Ditto, snow-bird, seals. |
| ne clear weather | 10 Am. | Cirro-stratus, &c. | Ditto, fulmars. |
| me snow | All day | Nimbus. | Bottlenoses, fulmars, &c. |
| ish snow | Am. | Nimbus. | Fulmars. |
| ne cloudy weather | | | Ditto, rotches, bottlenoses. |
| ow shwrs. frost-rime | Am. | Nimbus. | Ditto, snow-birds. |
| ow showers | Am. | Nimbus. | Ditto, bottlenoses. |
| me ditto | All day | Nimbus. | Ditto. |
| me hail | All day | Nimbus. | Fulmars, teistics. |
| ow showers snow | Morng. | Nimbus. | Ditto. |
| me snow showers | Am. | Nimbus. | Ditto, and rotches. |
| tto | | Nimbus. | Burgomaster, fulmars, &c. |
| tto | Am. | Nimbus, cumulus. | Bottlenoses, fin-whale, &c. |
| me cloudy weather | Pm. | Cumulus, nimbus. | Ditto, fulmars, &c. |
| owers of snow | | Cirro-stratus. | Ditto. |
| ne weather | Noon. | Cumulus. | Cetaceous animals, few birds. |
| ish hazy weather | | Stratus. | Fulmars, rotches, &c. |
| tto, rain | | Fog. | Ducks, looms, &c. |
| tto, some snow | | Fog. | Ditto, ice-bird, kittywakes. |
| me snow showers | 8 Am. | Cirrus, nimbus. | Ditto. |
| ne clear weather | 10 Am. | Cirrus. | Ditto, razor-backs. |

## *Meteorological Observations on a*

| Dates. | Latitude. | Longitude. | Therm. No. of Obs. | Therm. Mean. | Bar. at Noon. | Winds. | Strength of |
|---|---|---|---|---|---|---|---|
| | | | | | In. | | |
| April 21 | 76°32′ | 11° 0′E. | 3 | 13 | 30 19 | E by S calm | Chiefly calm |
| 22 | 76 28 | 10 50 E. | 3 | 13 | 30 30 | Calm, N W, &c. | To moderate |
| 23 | 76 34* | 10 20 E. | 3 | 18⅓ | 30 47 | N W, calm | To calm |
| 24 | 76 45 | 10 45 E. | 3 | 23 | 30 12 | Calm, variable | To fresh gale |
| 25 | 76 58 | 10 20 E. | 3 | 20⅓ | 29 82 | N W to N E.rly | Variable brisk |
| 26 | 77 00* | 10 20 E. | 3 | 9 | 30 02 | N E.erly | Strong gales |
| 27 | 76 58 | 10 0 E. | 2 | 12 | 30 07 | Ditto | Lt. br. to fres |
| 28 | 77 4′10″* | 8 50′32″E.* | 3 | 20⅔ | 30 17 | E N E to North | To light breez |
| 29 | 77 00 | 8 50 E. | 3 | 20⅓ | 30 05 | to N E and N W | To calm |
| 30 | 77 8 | 8 48 | 3 | 17 | 30 07 | S W to S S E | Fresh breezes |
| May 1 | 77 15 | 8 20 E. | 3 | 16⅔ | 30 17 | N E to S S E | Moderate brez |
| 2 | 77 17* | 8 10 E. | 3 | 18⅓ | 30 17 | to East | Ditto |
| 3 | 77 22 | 8 0 E. | 3 | 21⅔ | 29 87 | E.rly to S E to | Fresh breezes |
| 4 | 77 27 | 7 50 E. | 3 | 21 | 29 75 | E N E | Fresh gales |
| 5 | 77 34* | 7 50 E. | 3 | 19 | 29 71 | Calm, variable | Light airs and |
| 6 | 77 32* | 7 58 E. | 3 | 10⅔ | 29 78 | N W.erly | Fresh breezes |
| 7 | 77 28 | 8 04 E. | 3 | 9 | 29 80 | N W by N | Strong gales |
| 8 | 77 24 | 8 10 E. | 3 | 8⅔ | 30 02 | N N W | Ditto, strong |
| 9 | 77 26 | 8 10 E. | 3 | 22 | 30 03 | S W to N W | Fresh gales |
| 10 | 77 10* | 8 10 E. | 3 | 19 | 30 08 | to North | Do. or moder |
| 11 | 77 06 | 8 03 E. | 3 | 9 | 30 15 | to N N W | Fresh gales |
| 12 | 77 01* | 8 05 E. | 3 | 20 | 30 00 | to S by W or S by E | To light airs |
| 13 | 77 04 | 8 10 E. | 3 | 20 | 29 63 | to S W or W by N | Hard gales |
| 14 | 77 02 | 8 15 E. | 3 | 12 | 29 73 | to N W | Strong gales |
| 15 | 77 02 | 8 56 E. | 3 | 13⅓ | 29 92 | N W and var. | Fresh gales |
| 16 | 77 00 | 8 59 E. | 3 | 21 | 29 95 | Calm, light air | Calm, light air |
| 17 | 77 00 | 9 00 E. | 3 | 21 | 29 80 | N.erly | Moderate brez |
| 18 | 76 46* | 8 46 E. | 3 | 21 | 30 0 | Ditto, variable | Light breezes |
| 19 | 76 54 | 8 38 E. | 3 | 23 | 29 94 | Ditto, to S E.rly | Do. and steady |
| 20 | 77 05 | 8 30 E. | 3 | 21 | 29 77 | S E.rly | Hard gales, fi |
| 21 | 77 20* | 8 28 E. | 3 | 22⅔ | 29 89 | to N E.rly | Calm, light ai |
| 22 | 77 22 | 8 00 E. | 3 | 27 | 29 68 | S E.rly, N E.rly | Moderate brez |
| 23 | 77 16 | 8 16 E. | 3 | 23⅓ | 30 06 | N N E, variable | Light breezes |
| 24 | 77 14 | 8 50 E. | 3 | 25 | 30 16 | to N N W | Ditto |
| 25 | 77 24 | 9 10 E. | 3 | 25 | 29 98 | N W.rly | To fresh breez |
| 26 | 78 00 | 9 50 E. | 3 | 25⅓ | 29 90 | to North | To strong gale |
| 27 | 78 15 | 9 30 E. | 3 | 21⅔ | 29 86 | N by E | Hard gales |
| 28 | 78 20 | 9 30 E. | 3 | 23 | 29 90 | N by E | Strong gales |
| 29 | 78 22* | 9 27 E. | 3 | 22⅓ | 30 08 | N by E | Ditto |
| 30 | 78 28 | 5 40 E. | 3 | 22 | 30 09 | to N, variable | Fresh breezes |
| 31 | 78 34 | 5 35 E. | 3 | 26⅓ | 29 98 | to N W.rly | Light breezes |

## *Greenland Voyage*, 1811.

| Weather, &c. ueous Meteors. | Of the Clouds. | | Birds, &c. seen. |
|---|---|---|---|
| | Time. | Modifications. | |
| ear weather | All day | Cirro-stratus. | Narwh. seals, mysticetus, fulms. |
| mall snow showers | Am. | Cirrus, &c. | Mysticetus, seals, fulmars, &c. |
| ear weather | 8 Pm. | Cirrus, &c. | Seals, narw. fulms. burgomaster. |
| now | All day | Nimbus. | Ditto. |
| | | Nimbus. | Seals, &c. |
| y showers | Am. | Nimbus. | Razor-backs, seals, &c. |
| | | Nimbus. | Seals, &c. birds. |
| ther | 11 Pm. | Stratus. | (Uncom. refract.) whales, narw. |
| owers | | Nimbus. | Whales, narw. seals, &c. |
| mall snow | | Nimbus. | Fulmars and looms. |
| owers | | Nimbus. | Ditto, birds, &c. |
| weather, little snow | 9 Pm. | Cirro-cumulus, &c. | Many common birds. |
| owers | Am. | Nimbus. | Mysticete, &c. birds. |
| now | | Nimbus. | Ducks, looms, whales. |
| showers | Am. | Nimbus, &c. | Few birds seen. |
| showers | Am. | Cirro-stratus, &c. | Whales, fulmars, &c. |
| ht. snow | | Nimbus. | Ditto, snow-birds. |
| illized | | Cirro-cumulus. | Ditto. |
| owers | | Cirro-stratus. | Ditto, snow-bunting. |
| small snow | Most day | Stratus. | Fulmars, looms, snow-birds. |
| snow showers | | Nimbus. | Many common birds. |
| | 8 Pm. | Cirrus. | Whales, narwals, seals. |
| ow | | Cirro-stratus, &c. | Ditto. |
| | | Nimbus. | Ditto, looms. |
| mall snow | | Nimbus, stratus. | Razor-backs, looms, &c. |
| owers | All day | Nimbus. | Common birds. |
| now | All day | Nimbus. | Do. sea-horse, (walrus.) |
| | | Nimbus. | Walrus, narw. mystic. birds. |
| now showers | Most day | Nimbus. | Narwal, common birds. |
| mall snow | Pm. | Nimbus, cirrus. | Common birds. |
| ear weather | Am.&Pm. | Cirrus, &c. | Narw. whales, seals, and ditto. |
| now | 8 Pm. | Cirrus. | Ditto. |
| ine weather | Am. | Cirrus. | Ditto, fulmars, &c. |
| ther, cloudy | | Stratus. | Ditto. |
| now | | Nimbus. | Narw. seals, ditto. |
| weather | | | Common birds. |
| now showers | 6 Pm. | Cirrus, nimbus. | Ditto. |
| weather | | | Two whales. |
| ear weather | | Cirrus. | Bottlenoses, common birds. |
| loudy weather | Morning | Cirrus. | Whales, common birds. |
| showers | Am. | Cirrus. | Many whales, ditto. |

## *Meteorological Observations on a*

| Dates. | Latitude. | Longitude. | Therm. No. of Obs. | Therm. Mean. | Bar. at Noon. | Winds. | Strength of |
|---|---|---|---|---|---|---|---|
| | | | | | In. | | |
| June 1 | 78°34′ | 5°38′ E. | 3 | 25 | 30 04 | N W to N E | Light or fres |
| 2 | 78 36 | 6 10 | 3 | 22⅓ | 30 04 | N.erly, variable | To moderate |
| 3 | 78 34 | 6 10 | 3 | 30⅓ | 29 96 | Very variable | Light breeze |
| 4 | 78 38 | 5 58 | 3 | 28 | 29 96 | E.rly, N E.rly | Ditto |
| 5 | 78 29 | 5 54 | 3 | 29⅔ | 29 83 | to variable | Fresh to light |
| 6 | 78 40 | 6 10 | 2 | 28½ | 29 80 | N E to E | Ditto to fresh |
| 7 | 79 20 | 8 00 | 3 | 30⅔ | 29 63 | E to S S E | Strong gales |
| 8 | 79 10 | 7 50 | 3 | 29⅓ | 29 63 | S.erly, variable | Fresh gales |
| 9 | 78 58 | 7 00 | 3 | 30⅓ | 29 92 | S by W to S W | Moderate bre |
| 10 | 78 58 | 6 58 | 3 | 33⅔ | 29 95 | to S or S E · | Light breezes |
| 11 | 78 58* | 6 00 | 3 | 31 | 29 93 | E.rly, variable | To moderate |
| 12 | 78 56 | 5 50 | 3 | 28 | 29 95 | N E.rly | Ditto |
| 13 | 78 40 | 5 30 | 3 | 29 | 29 88 | Ditto and var. | Light airs |
| 14 | 78 45 | 5 15 | 3 | 30⅓ | 29 76 | Very variable | Light airs or |
| 15 | 78 45 | 5 13 | 3 | 32⅔ | 29 78 | E.rly, &c. | Ditto |
| 16 | 78 42 | 5 10 | 3 | 33 | 29 83 | S E.rly, N E, &c. | Ditto |
| 17 | 78 40 | 5 08 | 3 | 32⅓ | 29 86 | N E or N E by N | Moderate or |
| 18 | 78 36 | 5 10 | 3 | 30⅔ | 29 87 | N E by N | Fresh gales |
| 19 | 78 15* | 5 04 | 3 | 31 | 29 90 | N E by N | Fresh breeze |
| 20 | 78 10 | 5 00 | 3 | 33⅓ | 29 92 | Variable | To light bre |
| 21 | 78 15 | 5 00 | 3 | 32 | 29 62 | S W.erly, var. | Light airs, c |
| 22 | 78 11 | 5 15 | 3 | 35 | 29 62 | S.erly, variable | Ditto |
| 23 | 78 17 | 5 25 | 3 | 33 | 29 66 | to E or S W | To moderate |
| 24 | 78 20 | 5 26 | 3 | 34 | 29 68 | to W.rly | Light breeze |
| 25 | 78 21 | 5 26 | 3 | 33 | 29 50 | Very variable | Do. and mod |
| 26 | 78 35 | 5 54 | 3 | 32 | 29 64 | N W, S.rly | Do. and fres |
| 27 | 78 15 | 5 50 | 2 | 35 | 29 53 | Very variable | Ditto dit |
| 28 | 78 04 | 5 00 | 3 | 32⅔ | 29 94 | Ditto | Fresh gales, |
| 29 | 77 59′30″* | 5 15 | 3 | 33 | 30 10 | S E.rly, variable | Light to fres |
| 30 | 78 50 | 6 40 | 3 | 35⅔ | 29 94 | S E.rly, ditto | Do. or strong |
| July 1 | 78 40 | 7 18 | 3 | 35 | 30 04 | Variable | Light or mod |
| 2 | 78 20 | 6 30 | 3 | 34 | 30 13 | S W.rly | Moderate bre |
| 3 | 78 00 | 6 00 | 2 | 36 | 30 03 | S W to S | Ditto |
| 4 | 77 58 | 5 40 | 3 | 40 | 29 88 | to S E by S | Moderate or |
| 5 | 77 56* | 6 00 | 2 | 42 | 29 94 | to S W.rly | Light or mod |
| 6 | 77 48 | 6 58 | 2 | 40 | 29 98 | S.erly, variable | Ditto |
| 7 | 77 48 | 7 20 | 3 | 41 | 30 07 | to S W, variable | Ditto or calm |
| 8 | 76 36 | 9 20 | 2 | 39 | 30 00 | W to S W by W | Fresh gales |
| 9 | 75 40 | 11 36 | 3 | 40 | 29 98 | W.erly, calm | Fresh breeze |
| 10 | 75 15 | 12 00 | 2 | 39 | 29 95 | S W.erly | Ditto |
| 11 | 74 52* | 11 00 | 3 | 40⅓ | 29 97 | W.erly, variable | Moderate br. |
| 12 | 74 10* | 11 00 | 3 | 41⅓ | 29 87 | E.erly | Light breeze |

## *Greenland Voyage*, 1811.

| ather, &c. ous Meteors. | Of the Clouds. | | Birds, &c. seen. |
|---|---|---|---|
| | Time. | Modifications. | |
| ow showers | Am. | Nimbus, cirrus. | Whls. burgomrs. fulms. kittyws. |
| azy | | Stratus, nimbus. | Ditto. |
| ow showers | Am. | Nimbus, cumulus. | Numerous whales, narw. fulms. |
| owers | Am. | Nimbus, &c. | Several whales, ditto. |
| ather, some sn. | | Nimbus, stratus. | Many common birds. |
| owers | Often. | Nimbus. | Narwals, and a few birds. |
| zy | | Nimbus, stratus. | Few living animals. |
| haze | | Nimbus. | A narwal seen. |
| owers of snow | | Nimbus. | Narwal, fulmars, kittywakes. |
| ditto | | Nimbus. | Ditto, ditto. |
| r weather | Am. | Cirro-cumulus, &c. | Whales, narw. seals, bears. |
| oudy | | Nimbus. | Seals, some whales, birds. |
| owers snow | | Nimbus. | Ditto. |
| aze | | Nimbus. | Whales, narwals. |
| dy weather | | Nimbus, &c. | Many ditto, ditto. |
| fog | Midnt. | Stratus. | Ditto. |
| r weather | Am. | Nimbus, stratus. | Ditto. |
| ther | Midnt. | Nimbus, cirrus. | Whales, common birds. |
| r clear | | Cirrus, nimbus. | Ditto, ditto. |
| vers | | Nimbus. | Ditto, narw. and ditto. |
| | | Nimbus, &c. | Ditto, ditto. |
| in | | Nimbus. | Few ditto. |
| vers | | Cirro-cumulus, &c. | Ditto. |
| lear | | Nimbus. | Some whales and birds. |
| owers | | Cirro-cumulus, &c. | Ditto, ditto. |
| g showers | | Nimbus. | A few ditto. |
| | | Nimbus, stratus. | Ditto, ditto. |
| fog | | Cirro-cumulus. | Ditto, narw. bears, seals. |
| now showers | | Nimbus. | Ditto, seals, &c. |
| | | Nimbus. | 2 Whales, seals, fulms. rotches. |
| ow showers | | Nimbus. | Ditto. |
| | | Cirro-cumulus, &c. | 2 Whales, ditto. |
| in | Pm. | Cirro-cumulus, &c. | Some whales and birds. |
| r weather | Noon. | Cirrus. | Ditto, seals. |
| vers | Am. | Cirrus. | Common birds. |
| | | Nimbus, &c. | One whale and ditto. |
| lear | Noon. | Nimbus, cirrus. | Razor-back, fulmars. |
| vers | | Fog. | Narw. seals, few birds. |
| vers | Pm. | Cirrus. | A few fulmars. |
| aze | | Fog. | Ditto. |
| | | Fog. | Bottlenoses, razor-backs. |
| og | Noon. | Cirro-cumulus, &c. | Razor-back, fulmars. |

## *Meteorological Observations on a*

| Dates. | Latitude. | Longitude. | Therm. No. of Obs. | Therm. Mean. | Bar. at Noon. | Winds. | Strength of W |
|---|---|---|---|---|---|---|---|
| | | | | | In. | | |
| July 13 | 73°10′ | 9°25′ | 3 | 40⅓ | 29 87 | To S S E | To fresh breez |
| 14 | 72 17 | 7 57 | 3 | 41 | 29 94 | Variable | To calm |
| 15 | 72 10 | 6 27 | 2 | 42 | 30 05 | N W to S W | Light breeze, c |
| 16 | 71 24 | 3 57 | 3 | 43 | 29 89 | S.erly, variable | Fresh breeze, |
| 17 | 70 36 | 2 40 | 3 | 43 | 29 94 | N W, variable | Mod. breeze, c |
| 18 | 70 30* | 2 05 | 3 | 46⅓ | 29 97 | S.erly | Calm, to mod. |
| 19 | 70 15* | 1 05 W. | 3 | 46⅓ | 30 01 | Ditto, &c. | To light breez |
| 20 | 69 31 | 3 50 | 3 | 46⅔ | 30 00 | S.erly | Mod. or fresh b |
| 21 | 68 43* | 4 35 | 3 | 46⅔ | 30 07 | to S W | Fresh gales, & |
| 22 | 68 28 | 4 46 | 3 | 46⅔ | 30 02 | S.erly, variable | Mod. or fresh |
| 23 | 66 48 | 5 11 | 3 | 47 | 29 54 | Ditto | To strong gale |
| 24 | 66 35′31″* | 7 57 | 3 | 47 | 29 46 | Ditto | Fr. br. and fr. |
| 25 | 65 30 | 8 28 | 3 | 47⅓ | 29 33 | to S.erly | To strong gale |
| 26 | 63 3* | 7 9′45″ * | 3 | 48⅔ | 29 95 | N by W | To fresh gales |
| 27 | 61 33 | 4 43 | 3 | 52 | 30 02 | N W.erly | Moderate breez |
| 28 | 60 56 | 3 48 | 3 | 55⅓ | 29 03 | S.erly | Ditto or calm |
| 29 | 60 00* | 1 50 | 3 | 56⅓ | 30 09 | to W.erly | Light or mod. |
| 30 | 58 39* | 1 30 | 3 | 61¼ | 30 25 | W W or S W | Ditto |
| 31 | 58 14* | 1 46 | 2 | 66 | 30 15 | N W to S E | Ditto, calm |
| August 1 | 57 37* | 1 30 | 3 | 61⅓ | 30 10 | S or S W | Fresh breeze |
| 2 | 57 69 | 1 44 | 2 | 60½ | 29 82 | S to S W by S | Fresh gales |
| 3 | 56 37 | 2 17 | 2 | 56⅔ | 29 76 | S.erly, variable | To calm |
| 4 | 56 14 | 1 35 | 3 | 63 | 29 78 | S.erly, variable | To fresh breez |
| 5 | 55 30 | 0 54 | 3 | 67⅓ | 29 80 | W.erly | Moderate brez |
| 6 | 54 50 | 0 26 | 2 | 65½ | 29 63 | S W to S E | To light breez |
| 7 | Whitby Harbour | | 2 | 66 | 29 60 | N N W, W | Fresh or mod. |

## *Greenland Voyage*, 1811.

| Dates. | Weather, &c. Aqueous Meteors. | Of the Clouds. | | Birds, &c. seen. |
|---|---|---|---|---|
| | | Time. | Modifications. | |
| July 13 | Fog showers | | Fog. | Fulmars. |
| 14 | Much fog | | Fog. | Razor-back and fulmars. |
| 15 | Ditto | | Fog. | Ditto and looms. |
| 16 | Some rain | Noon. | Cirro-cumulus, &c. | Several ditto, looms, fulmars. |
| 17 | Fog | | Fog. | Some whitish fulmars. |
| 18 | Ditto | 11 Am. | Cirro-cumulus, &c. | Young gulls or kittywakes. |
| 19 | Much fog | 11 Am. | Cirro-stratus. | Ditto, seal. |
| 20 | Ditto | | Fog. | Ditto, fulmars. |
| 21 | Rain or fog | | Fog. | Fulmars. |
| 22 | Rain or fog | 3 Pm. | Cirro-cumulus, &c. | Ditto. |
| 23 | Much rain or fog | | Fog. | Several fulmars. |
| 24 | Fog or rain | 3 Pm. | Cirrus, &c. | Ditto. |
| 25 | Ditto | | Nimbus. | Ditto. |
| 26 | Cloudy | 11 Am. | Cirro-cumulus, &c. | Fulm. arc. gull, loom, solan-geese. |
| 27 | Fine cloudy weather | Am | Nimbus. | Young gulls, ditto. |
| 28 | Some rain | 10 Pm. | Cirrus. | Ditto, &c. |
| 29 | Showers of rain | 2 Am. | Nimbus, &c. | Ditto. |
| 30 | Ditto | | Cirro-cumulus. | Young gulls. |
| 31 | Fine clear weather | Noon. | Cirro-cumulus, &c. | Cod-fish, turbot, skate, &c. |
| August 1 | Cloudy weather | Noon. | Cirro-cumulus, &c. | Gulls, mackrel. |
| 2 | Showery | Pm. | Cirro-stratus, &c. | Ditto. |
| 3 | Showers rain | Am. | Nimbus. | Gulls, gurnards. |
| 4 | Much rain | Noon. | Cirrus, &c. | Gulls, looms. |
| 5 | Some rain | Pm. | Cirro-cumulus, &c. | Gulls. |
| 6 | Some rain | Am. | Nimbus, cirrus. | Ditto. |
| 7 | Showers rain | Am. | Cirrus. | Ditto, &c. |

HAVING now given a meteorological register, carefully kept by myself, on a voyage from Whitby to Greenland, and back, I may be permitted to annex a few remarks on the great utility of the Barometer and Thermometer at sea. When these instruments are well attended to, they will seldom fail to enable us to predict any great atmospheric change: and if the oscillations of each instrument be *connectedly* studied, not only the strength of the coming wind, but its direction and continuance may be guessed at, and with very considerable accuracy. An extract from my private journal will strikingly prove the truth of the above assertion.

" On April the 5th 1811, latitude 70°49′, and longitude 7°15′ E, the barometer had stood at 29.88, for about thirty-five hours; the mean of three observations of the thermometer during the day, was 11½°, the wind blowing a fresh gale from the northward. At noon, on the following day, we had a moderate breeze of wind at north-west, which, towards evening, increased to a fresh gale, exceedingly variable and squally, accompanied with thick showers of *flaky* snow. At 3 PM. the thermometer had risen to 17°, and at 6 PM. to 27°. This remarkable rise of 17 degrees of temperature in nine hours, made me suspect, a south-east wind was about to prevail, and because the barometer had fallen to 29.50, a severe storm might be expected. Since the barometer stands highest on

E. or S E. winds, had it not fallen we should have expected a storm, on its veering from N W. to the opposite quarter; but, when accompanied by a fall of near four-tenths of an inch, a most violent gale would be likely to ensue. I walked the deck somewhat alarmed at the awful appearance of the sky, in the short intervals of the showers. At one time, a strong light, like that seen reflected on the horizon by the rising or setting sun, appeared stretching from the N N E, to the E S E, but more correctly corresponding with the phenomenon of the *ice-blink*, which is a strong light reflected from the ice into the atmosphere above it, and in clear weather is almost always seen when at the distance of fifteen or twenty miles from any compact body of ice. This white light, I soon ascertained, did not proceed from any ice *. The sun was neither in the same quarter nor opposite.

"In the midst of a thick shower, (wind still N W to N N W,) I observed the snow to clear away to lee-ward, which assured me of the wind being about to *shift*. Immediately all hands were ordered on deck to attend the sails, and every man at his station, awaited the event. In about ten



* Some time afterwards, when mentioning this circumstance to an old Greenland commander, he told me he had himself more than once seen the phenomenon I described, and always considered it as a prognostic of a storm; at the same time, its position pointed out the quarter from whence it would commence.

## *A Meteorological Journal of a*

| Dates. | Latitude. | Longitude. | Therm. No. of Obs. | Bar. at Noon. | Winds. | Strength of Wi |
|---|---|---|---|---|---|---|
| | | | | In. | | |
| May 1 | 74°30′ N. | 15°13′ E. | 3 25 | 30 20 | N W to N | Fresh gales |
| 2 | 75 23 | 14 25 | 3 23 | 30 37 | N E to S E.rly | Mod. to fresh gal |
| 3 | 75 35 | 10 43 | 3 13 | 29 45 | to S E & E by N | Very hard gales |
| 4 | 74 36 | 10 0 | 3 13 | 29 89 | E b N to N E b E | Hard gales |
| 5 | 73 41 | 10 40 | 3 12 | 29 75 | to N E | Ditto |
| 6 | 73 10 | 10 18 | 3 17 | 29 64 | N E | Ditto |
| 7 | 72 58 | 10 19 | 3 22 | 29 89 | to N N E | Fresh gales |
| 8 | 73 33 | 10 21 | 3 24 | 29 94 | to N N W, var. | Fresh breezes |
| 9 | 73 57 | 10 21 | 3 25 | 30 05 | Very variable | Light breezes |
| 10 | 74 28 15″ | 9 37 | 3 27 | 30 03 | N W.rly, var. | Do. or calm |
| 11 | 75 36* | 8 8 | 3 31 | 29 90 | S E by E, E.rly, | Fresh gales |
| 12 | 75 38 | 8 20 | 3 27 | 29 83 | N E, N N E | Light to strong b |
| 13 | 75 52* | 9 20 | 4 23 | 29 77 | N.rly, variable | Strong breeze |
| 14 | 76 12 | 10 20 | 4 23 | 29 88 | W.rly, S.rly | Moderate breezes |
| 15 | 76 15* | 9 0 | 3 32 | 29 70 | S to S E | Fresh breezes |
| 16 | 76 20 | 9 40 | 3 30 | 29 50 | N E.erly | Strong gales |
| 17 | 76 7* | 9 30 | 3 21 | 29 85 | to N N W | Hard gales |
| 18 | 76 37* | 10 45 | 3 22 | 29 75 | Very variable | Moderate gales |
| 19 | 76 30 | 10 45 | 3 20 | 29 93 | N by W | Strong gales |
| 20 | 76 30 | 10 30 | 3 18 | 30 03 | N by W | Fresh or strong g |
| 21 | 76 30 | 10 00 | 3 19 | 29 80 | N by W | Strong gales |
| 22 | 76 20 | 10 00 | 3 20 | 29 66 | N by W | Very strong gales |
| 23 | 76 10* | 10 0 | 3 25 | 29 90 | to N W by N | Strong gales |
| 24 | 76 5 | 10 0 | 3 27 | 30 00 | N W by N, var. | To light breeze |
| 25 | 75 58* | 10 0 | 4 30 | 30 06 | N.rly, variable | Light breeze |
| 26 | 75 50* | 9 40 | 3 33 | 30 13 | N E.rly | Ditto |
| 27 | 75 57 | 9 0 | 3 29 | 30 16 | Variable | Inclinable to calm |
| 28 | 75 50 | 9 20 | 3 29 | 30 28 | S.rly, S W.rly | Ditto |
| 29 | 76 0 | 9 20 | 3 29 | 30 28 | S.rly, S W.rly | Ditto |
| 30 | 76 20 | 10 0 | 3 29 | 30 32 | S E.rly | Ditto |
| 31 | 76 30 | 10 50 | 3 28 | 30 32 | S E, S W.erly | Ditto |
| June 1 | 77 14 | 9 5 E. | 3 30 | 30 37 | S W to W | Moderate gales |
| 2 | 78 15 | 5 27 | 3 31 | 30 37 | S.rly, variable | Mod. br. and ditt |
| 3 | 78 50 | 7 0 | 3 31 | 30 34 | S E.rly, &c. | Strong gales |
| 4 | 78 30 | 5 30 | 3 32 | 29 96 | S E by E | Moderate gales |
| 5 | 78 30 | 5 30 | 3 33 | 29 90 | S.rly | Fresh breeze |
| 6 | 78 26 | 5 45 | 3 34 | 29 87 | S.rly, variable | Light breeze |
| 7 | 78 00 | 5 45 | 3 33 | 29 87 | Calm, N.rly | Calm, fresh bree |
| 8 | 78 00 | 6 45 | 3 25 | 30 10 | N to N W | Strong gales |
| 9 | 78 00 | 6 30 | 3 25 | 30 00 | to W by N | Light breeze |
| 10 | 77 54 | 6 15 | 3 29 | 29 80 | N.rly, variable | Fresh breeze |

## *Greenland Voyage*, 1812.

| Weather, &c. ueous Meteors. | Of the Clouds. | | Animals, &c. seen. |
|---|---|---|---|
| | Time. | Modifications. | |
| idy weather | | Not distinct. | Ducks, fulmars, looms, rotches, &c. |
| much snow | | | Common birds, razor-backs. |
| r showers | | | Fulmars only. |
| r | | | Fulmars, rotches. |
| to | | | Ditto. |
| to | | Frost-rime. | Ditto. |
| to | | Nimbus. | Ditto. |
| to | | Nimbus. | Ducks, fulmars, rotches. |
| h snow | | Nimbus, cirrus. | Many ducks, burgomasters, &c. |
| r showers | Am. | Cirrus, nimbus. | Many seals, ditto, birds. |
| to | | Nimbus. | Common birds, 2 whales. |
| idy weather | | Ice-blinks. | 2 Whales, seals, common birds. |
| to | | Ditto. | 2 or 3 whales, ditto. |
| snow | | Ditto. | 1 whale, narwals, seals, snowbirds. |
| to | | Dense clouds. | Seals and common birds. |
| h snow | Am. | Nimbus. | Ditto, ditto. |
| udy | Pm. | Nimbus. | Ditto, ditto. |
| ttimal snow | All day. | Nimbus. | A whale. |
| ick snow | | Frost-rime. | Narwal, seals, common birds. |
| ch snow | | Ditto. | A whale, common birds. |
| to | | Ditto. | ditto. |
| to | All day. | Nimbus. | No whales, ditto. |
| ne snow | | Nimbus, &c. | Common birds. |
| e weather | | Nimbus, &c. | |
| to | | Nimbus, &c. | Narwals. |
| to | | Nimbus. | Ditto, whales. |
| to | Am. | Cirrus, &c. | Some whales, narwals, &c. |
| to | Am. | Cirro-cumulus. | Ditto, seals, common birds. |
| to | | Cirro-cumulus, &c. | Ditto, ditto. |
| to | All day. | Cirro-cumulus, &c. | Common birds. |
| to | | Cirro-cumulus, &c. | Ditto. |
| udy weather | | | Common birds. |
| h snow | | Ice-blinks. | Seals, some whales. |
| w showers, fog | | Nimbus. | ditto. |
| g showers | | | |
| ick fog, rain | | Fog. | Ditto. |
| stant fog | | | Common birds. |
| g showers | | | White whales, narwals, seals, &c. |
| e clear weather | Pm. | Cirro-cumulus. | Several whales. |
| to | | Cirro-cumulus, &c. | Many whales. |
| w showers | | Cirrus, nimbus. | Many whales, narwals, ducks. |

## *A Meteorological Journal of a*

| Dates. | Latitude. | Longitude. | Therm. No. of Obs. | Bar. at Noon. | Winds. | Strength o |
|---|---|---|---|---|---|---|
| | | | | In. | | |
| June 11 | 78°44′ * | 6°30′ | 4 25 | 29 77 | N E.rly | Strong gales |
| 12 | 78 58 | 6 30 | 4 24 | 29 88 | N E to N N E | Fresh breez |
| 13 | 78 56 | 6 30 | 3 26 | 29 68 | N.erly, variable | Strong gales |
| 14 | 78 50 | 6 30 | 3 27 | 29 77 | E N E, N N E | Strong gale |
| 15 | 78 40 | 6 15 | 3 30 | 29 80 | N N E | To fresh ga |
| 16 | 79 26 | 6 45 | 3 27 | 29 77 | N E by N | |
| 17 | 78 30 | 6 00 | 4 29 | 29 86 | N W | Fresh breez |
| 18 | 78 20 | 6 00 | 3 32 | 29 80 | W, S W, E | Light breez |
| 19 | 78 10 | 6 00 | 3 32 | 29 78 | E, N E.rly, | Calm, fresh |
| 20 | 78 17 | 6 00 | 2 26 | 29 79 | N N E | Fresh breez |
| 21 | 78 25 | 6 30 | 3 29 | 29 70 | N N E | Strong gales |
| 22 | 78 32 | 6 30 | 3 28 | 29 74 | N N E | Fresh gales |
| 23 | 78 30 | 6 15 | 3 30 | 29 80 | Variable | Light breeze |
| 24 | 78 5 | 6 35 | 3 33 | 29 55 | Ditto | To strong g |
| 25 | 78 9* | 6 45 | 3 32 | 29 95 | N E.rly | Fresh gales |
| 26 | 78 10 | 6 40 | 3 33 | 29 97 | N.rly | Light breeze |
| 27 | 77 59* | 6 07 | 2 34 | 29 86 | N N E, N N W | Fresh breeze |
| 28 | 78 00 | 6 00 | 3 36 | 29 65 | N.rly | Moderate bre |
| 29 | 77 48 | 6 50 | 3 34 | 29 55 | N.rly | To fresh bre |
| 30 | 77 30 | 6 45 | 3 33 | 29 50 | Very variable | Moderate bre |
| July 1 | 77 54 | 6 15 E. | 3 35 | 29 45 | E S E to E N E | Ditto |
| 2 | 78 9* | 6 30 | 3 35 | 29 77 | E.rly, variable | To fresh bre |
| 3 | 78 20 | 6 30 | 3 33 | 29 40 | N E.rly | Strong gales |
| 4 | 78 18 | 6 40 | 3 32 | 29 42 | N and variable | Moderate or |
| 5 | 78 10 | 6 45 | 3 32 | 29 72 | S W | To strong bre |
| 6 | 78 5 | 6 30 | 3 32 | 29 90 | S W and W.rly, | Fresh or mod |
| 7 | 78 58 | 6 45 | 3 33 | 30 00 | W.rly | Calm or light |
| 8 | 77 40 | 6 10 | 3 32 | 29 90 | W S W, S W | Moderate or |
| 9 | 77 30 | 6 00 | 3 32 | 29 84 | S W to N N E | Ditto |
| 10 | 77 30 | 6 00 | 3 32 | 29 81 | N N W to N | To fresh gale |
| 11 | 78 00 | 5 30 | 4 32 | 29 90 | N N E to N N W | Strong gales |
| 12 | 77 56 | 5 30 | 4 33 | 29 87 | N N W to N E | Ditto |
| 13 | 77 46* | 5 27 | 3 37 | 30 03 | N E to N | Fresh breeze |
| 14 | 78 20 | 6 25 | 3 33 | 29 90 | N to N E by N | Strong gales |
| 15 | 77 40 | 5 20 | 3 33 | 29 76 | N E.rly | Ditto |
| 16 | 77 45 | 5 30 | 3 32 | 29 60 | N E to E & S E | Mod. to stro |
| 17 | 77 50* | 5 7 | 3 31 | 30 10 | S E | Strong gales |
| 18 | 77 59 | 5 00 | 3 32 | 30 32 | to E & N N E | Moderate bre |
| 19 | 78 00 | 5 00 | 3 32 | 30 12 | N & variable | Light airs, c |
| 20 | 78 00 | 5 00 | 3 35 | 30 13 | S W.rly | Moderate or |
| 21 | 78 00 | 4 50 | 3 34 | 30 20 | S.rly to E | Strong breez |
| 22 | 78 00 | 4 30 | 4 34 | 30 24 | E.rly | Fresh breeze |

## *Greenland Voyage*, 1812.

| eather, &c. eous Meteors. | Of the Clouds. Time. | Modifications. | Animals, &c. seen. |
|---|---|---|---|
| weather | All day | Cirro-cumulus, &c. | Many whales. |
| | All day | Cirrus, &c. | Ditto. |
| clear weather | Noon. | Cirrus, &c. | 2 whales, razor-backs, com. birds. |
| | | Cirrus, &c. | Common birds. |
| snow | All day | Cirro-cumulus, &c. | 3 Bears. |
| ly weather | | Ice-blinks. | Some few birds. |
| hrs, snow | All day | Nimbus. | Some whales, narwals, seals. |
| showers | | Fog. | Razor-backs. |
| snow | | Nimbus. | A few whales, razors, a bear. |
| ly weather | | Nimbus. | Ditto. |
| r snow | | Nimbus. | 1 Whale, 1 narwal, some birds. |
| | | Nimbus. | Some whales. |
| showers | | Nimbus. | A few whales, narwal, &c. |
| r snow | | Nimbus. | Several large whales. |
| clear weather | Pm. | Cirro-cumulus, &c. | Ditto, and narwals. |
| | Am. | Cirrus, &c. | Some large whales. |
| ers snow | Am. | Nimbus. | Some birds. |
| r snow | | Cirro-cumulus, &c. | Some whales, narws. birds, &c. |
| k fog | | Fog. | Two whales. |
| k snow | All day | Nimbus. | Two whales. |
| r and fog | All day | Nimbus, fog. | Some whales, seals, com. birds. |
| k fog | Noon. | Cirro-cumulus. | Razor-backs, sharks, whales, &c. |
| h snow | | | Ditto, some whales, seals, &c. |
| r showers | | Cirro-cumulus, &c. | Several whales. |
| s ditto | | Nimbus. | Ditto, seals, razor-backs. |
| r & fog shwrs. | | Nimbus. | Ditto, ditto, narwals. |
| | All day | Nimbus. | Ditto, ditto. |
| ly or fog | | Fog. | 2 or 3 whales. |
| hazy weather | | Do. showers. | Several whales. |
| weather | Pm. | Cirro-stratus, &c. | Many large whales, seals, &c. |
| r showers | | Nimbus, &c. | Whales, razors, seals, narwls. &c. |
| r showers | All day | Nimbus, &c. | Ditto, ditto, ditto. |
| showers | Am. | Cirrus, &c. | Common birds. |
| | Am. | Cirrus, &c. | 2 Whales, 1 razor, seals. |
| , or snow | All day | Fog, &c. | Some whales, many seals. |
| t fog | | | 3 ditto, thousands of seals |
| r snow shwrs. | | | Common birds, ditto. |
| | Am. | Cirrus, &c. | Several whales. |
| | | Fog, &c. | Many whales, seals, narwals. |
| howers | Pm. | Cirro-cumulus, &c. | Seals plenty, two sea-parrots. |
| veather | Pm. | Cirro-cumulus, &c. | Many whales, narws. seals, bears. |
| weather | Pm. | Nimbus. | Whales, ditto, ditto, ditto. |

## *A Meteorological Journal of a*

| Dates. | Latitude. | Longitude. | Therm. No. of Obs. | Bar. at Noon. | Winds. | Strength |
|---|---|---|---|---|---|---|
| | | | | In. | | |
| July 23 | 78°00′ | 4°30′ | 4 38° | 30 25 | S E | Light airs |
| 24 | 78 6* | 5 15 | 3 35 | 30 15 | S S W.erly | Ditto |
| 25 | 78 20 | 6 5 | 3 35 | 30 12 | S S W, W.rly | Calm chiefl |
| 26 | 77 44 | 6 39 | 3 32 | 30 00 | W.rly, N E | Strong bre |
| 27 | 76 4 | 6 48 | 3 33 | 30 00 | N E.rly | Moderate b |
| 28 | 73 26 | 6 45 | 3 38 | 29 80 | E N E | Fresh gale |
| 29 | 71 18 | 8 45 | 3 40 | 29 70 | E N E.rly | Strong gal |
| 30 | 70 3 | 2 5 | 3 41 | 29 70 | E.erly variable | Moderate b |
| 31 | 68 24* | 1 7 | 2 44 | 29 87 | Calm, N W.erly | Calm, frost |
| August 1 | 67 32 | 1 38 E. | 3 48 | 30 00 | S W to W.rly | Light airs |
| 2 | 66 47 | 1 17′30″W.* | 3 50 | 30 14 | S to S E.rly | Moderate b |
| 3 | 65 14 | 2 17 W. | 3 50 | 29 98 | S E.rly | Fresh brez |
| 4 | 64 35 | 2 42 | 3 50 | 30 04 | W to S W.rly | Light brez |
| 5 | 64 19 | 4 1 | 3 50 | 29 87 | S W or W.rly | Strong gal |
| 6 | 63 3′29″* | 3 16 | 3 50 | 30 17 | W variable | Light brez |
| 7 | 62 8 | 3 50 | 3 51 | 30 24 | N.rly, variable | Light or m |
| 8 | 60 13* | 3 50 | 3 53 | 30 17 | N.erly, do. | Strong bre |
| 9 | 58 57 | 1 55 | 3 53 | 30 10 | N E.rly | Strong gal |
| 10 | 56 56 | 0 42 | 3 54 | 30 13 | N E to N N E | Moderate b |
| 11 | 55 8 | 1 12 | 3 54 | 30 20 | N E.rly | Light brez |
| 12 | 54 31 | 0 30 | 3 58 | 30 22 | N E.rly | Ditto |
| | Whitby Roads. | | | | | |

## *Greenland Voyage*, 1812.

| eather, &c. eous Meteors. | Of the Clouds. | | Animals, &c. seen. |
|---|---|---|---|
| | Time. | Modifications. | |
| or fog | | Nimbus, &c. | 1 Whale, common birds. |
| weather, fog | Am. | Cirro-cumulus, &c. | 2 Whales, many narws. 3 bears. |
| k fog | | Fog. | Common birds and seals. |
| | | | Many fulmars. |
| | | | Ditto, burgomasters. |
| dy weather | | No distinct modn. | Ditto. |
| | | Rain. | Ditto. |
| k fog showers | | Fog. | Ditto. |
| k fog | | | Ditto. |
| ning fine wea. | Pm. | Cirro-cumulus, &c. | Bottlenoses, gulls, fulmars. |
| rain | All day. | Cirrus, &c. | Many gulls, arc. gulls, bottlenoses. |
| dy | Noon. | Nimbus, &c, | Ditto, ditto, ditto. |
| | Pm. | Cumulus, &c. | Ditto, fulmars. |
| dy, rain, fog | | | Many gulls. |
| weather | Pm. | Cirro-stratus, &c. | Many gulls. |
| k fog | | Fog. | Mollusca, sea-parrots, gulls, &c. |
| dy weather | Pm. | Stratus, &c. | Ditto, solan-geese, ditto, &c. |
| clear weather | Am. | Cirrus. | Gulls, ditto. |
| minous. *Light* | *ning.* | | Gulls, fulmars. |
| ning fine wea. | Am. | Cirrus, &c. | Gulls, willocks. |
| | Pm. | Cirrus, &c. | Gulls, willocks, &c. |

## XII. *Analyse du Spath perlée, (Chaux carbonatée ferrifère perlée d'Haüy.)*

By W. Hisinger, Esq. Stockholm.

*(Read 20th November 1813.)*

Parmi les substances minerales qui demontrent la nécessitée de l'application de l'analyse chimique à la classification systematique des mineraux, on pourra compter avec raison ceux que M. Haûy, dans son Traité de Mineralogie, a rangé sous l'espèce du Chaux carbonatée ferrifère avec manganèse, dans laquelle se trouve réuni le Fer spathique, le Spath brunissant (Braunspath), et sa variétée le Spath perlée. Dans le système de M. Werner, ces deux substances sont considerés comme differentes, et le Fer spathique est placé dans la classe des Mines de Fer. Plusieurs analyses de Klaproth, C. Descotils, Bucholz, &c. ont dejà consideré le Fer spathique comme une Mine de Fer carbonatée,

et une analyse de M. Klaproth *, place le Braunkalk sous la Chaux carbonatée magnésifère. Aussi les experiences suivantes prouveront que le Spath perlée, jugé d'après ses parties constituantes, doit être réuni à l'espèce de Chaux carbonatée magnésifère.

Le spath perlée qui vient d'etre l'objet de cet examen, est de couleur blanche, tirant un peu sur le jaunâtre. La surface est drusique, d'un éclat et de reflets nacrés, formant une croute sur d'autres cristaux. Dans l'interieur il est seulement chatoyant. Une goutte d'acide nitrique y laisse une tache jaunâtre. Le local inconnû, (Freiberg ?)

*a.*—10 grammes de spath perlée traité au feu pendant $\frac{3}{4}$ d'heures, ont perdu 4.460 grammes. La couleur s' est changé en grisâtre, et avee le borax il a donné au feu du chalumau une verre de couleur rouge-jaunâtre.

*b.*—10 autres grammes de la même substançe non rougi au feu, mais reduite en poudre, ont été dissoute avee effervescence dans l'acide muriatique étendu d'eau. Dans la dissolution, dont la couleur étoit verdâtre, l'ammoniaque caustique occassionnoit un précipité verdâtre d'oxidule de fer, qui pendant le lavage sur le filtre devenoit brun foncé. Ce précipité fut redissout dans l'acide muriatique mêlée d'acide nitrique. La dissolution fut etendu d'eau, neutralisée par l'ammoniaque caustique, et pre-

* Beiträge, t. 4.

cipitée par le benzoate d'ammoniaque. Le benzoate de fer, décomposé par le traitement au feu, laissoit 0.34 gr. oxide de fer. La liqueur neutralisée à froid par le carbonate de potasse, deposoit un précipité blanc, jaunissant par la dessication, devenant noir au feu, et pesant 0.07 gramme. Au reste, il se comportoit comme l'oxide pur de mangane. Cela fait, ayant ajouté à la liqueur en ebullition du carbonate de potasse en excès, on obtint un autre précipité, qui rougi au feu, devenoit grisâtre, pesoit 0.06 gramme, et qui fut enfin décomposé en 0.03 gramme d'oxide de mangane et 0.03 gr. de la magnésie.

*c.*—La dissolution muriatique, qui dans l'experience precedant (*b*) avoit été précipitée par l'ammoniaque caustique, fut un peu concentrée par l'évaporation, et après etre mis en ebullition mêlé avec du carbonate de potasse basique en excès jusqu' à la decomposition complette du sel ammoniacal. Dans cet operation on obtenoit un précipité blanc, un peu gelatineux au commencement, pesant 4.886 grammes, après etre lavé et traité à un feu très vif pendant une heure, dans un creuset decouvert. La couleur etoit grisatre. Il fut dissout au froid, et sans effervescence, dans l'acide nitrique étendu avec 30 parties d'eau, qui laissoit quelques flocons bruns d'oxide de mangane, pésant 0.05 gramme après etre rougi au feu.

*d.*—En ajoutant un peu de muriate d'ammoniaque à la dissolution, separé de mangane, elle

fut précipitée par le carbonate d'ammoniaque en excès, qui en séparoit le carbonate de chaux, dont le poids, après avoir été exactement et fortement séché, montoit à 4.96 grammes, équivalent à 2.797 grammes de la chaux caustique. La dissolution du sel triple contenu dans la liqueur restante, fut mis en ébullition, et decomposée par la potasse caustique. Le précipité, qui étoit blanc, se comportoit en tout comme la terre de magnésie, et contenoit les autres 2.084 grammes de la masse précipité en *c*.

Il résulte de l'analyse ci-dessus, que 10 grammes de spath perlée sont composés,

| | |
|---|---|
| De la chaux, *d* | 2.797 |
| Magnésie, *b*, *d* | 2.114 |
| D'oxide de fer, *b* | 0.340 |
| D'oxide de mangane, *b*, *c* | 0.150 |
| Acide carbonique, *a* | 4.460 |
| | 9.861 grammes. |

Ou, que 100 parties contiennent,

| | |
|---|---|
| Chaux, | 27.97 |
| Magnésie, | 21.14 |
| Oxide de fer, | 3.40 |
| Oxide de mangane, | 1.50 |
| Acide carbonique, | 44.60 |
| | 98.60 |
| Perte, | 1.40 |
| | 100.00 |

*Köping en Suede, le 15 Avril 1813.*

## XIII. *Outline of the Mineralogy of the Pentland Hills.*

By Professor Jameson.

(*Read 16th February* 1811.)

### Section I.

This beautiful group of hills, is situated in the counties of Mid-Lothian and Peebles. The nearest point is distant from Edinburgh, in a straight line, not less than four miles. It stretches from south-west to north-east, and extends from Dunsyre Hill to Kirkyetten Craig. As we approach its south-western extremity, it becomes gradually lower, and terminates in the flat country, which extends from Dunsyre Hill to the east bank of the river Clyde; but immediately to the south, it is connected with the great southern

alpine land of Scotland, by means of Mendeck Hill, the Dolphington Hills, and other hills. Its north-eastern extremity is lofty, in some places precipitous and cliffy, and the most prominent point is Kirkyetten Craig. The breadth of the group varies from three to eight miles: the hills of which it is composed, exhibit considerable variety in shape: those to the west of the river Esk are generally more or less round-backed, whereas those to the east of the same boundary, besides the round-backed shape, display also the more elegant conical and tabular forms: and its height is considerable, several of the hills being 1600 or 1700 feet above the level of the sea.

In this paper, it is my intention to describe only a part of the group, viz. that portion of it which extends from the bridge of Caerlips to Kirkyetten Craig, a distance of rather more than eight miles*; and which includes the whole of that part of the Pentlands contained in Mid-Lothian.

The south-western extremity of this portion of the group, joins with Caerlips Hill, Mount Hill, and other neighbouring hills: its north-eastern extremity is composed of several hills irregularly grouped together, with small valleys between, and of which, the Kirkyetten Hills are the most



* This part of the group is laid down in Laurie's map of the county of Mid-Lothian, published in 1763.

considerable. The space between the two extremities, is occupied by a double range of hills; which are separated from one another, in the first part of their course, by a high muirish plain, which extends from the source of the North Esk river to *Habbie's How*; and, in the remainder of their course, by a beautiful pastoral valley, through which Logan Water flows. A small range of low, generally round-backed hills, skirts the south side of the group, from Glencross Bridge, nearly to Caerlips; and several small hills skirt the grou — from Swanston, by Bonailly to Kinleith. Th hills vary considerably in height. The highe hills in the group, are Black Hill and Caarneth Hill, whose summits are 1700 feet above the level of the sea; Kirkyetten is 1544 feet above the level of the sea; Castlelaw, 1390 feet; and Spittal-Law, 1360 feet.

The hills also vary considerably in form. The most common shape is the *round-backed*, of which we have examples in the Kirkyetten Hills, Turnhouse Hill, Mucks Rig, Spittal Hill, Cock Rig, East Cairn Hill, Hare Hill, Black Hill, and Bald or Bield Hill. Others are *conical*, as the Kipps, Caernethy, Castlelaw, &c.: and some are *tabular*, as one of the tops of the hill named East Side Black Hill. The acclivities of the hills, although in general steep, are so covered with grass, as to afford excellent pasture: few cliffs occur, and none are of great height or extent: the most remarkable are those of Kirkyetten facing Edinburgh, and at Habbie's

How, over which the Logan Water is precipitated. The mode of connection of the individual hills, varies; in general they are connected by their summits or their acclivities.

The principal valleys in this portion of the group, are those of the Logan Water, and of the North Esk river. The Logan Water rises near the foot of the hill named Cock Rig, and runs for about a mile and a half, in a north-eastern direction, through the high muirish flat already mentioned, being bounded on the north side by Hare Hill, and on the south side by Spittal Hill and the Kipps, when it falls over a rocky precipice about eighty feet high at Habbie's How, into the delightful pastoral valley already mentioned. It continues its course through the whole extent of this valley, which is nearly three miles long, to its further extremity at Castlelaw. The valley is bounded on the north side by Black Hill and Bield Hill; on the eastern extremity by Castlelaw; on the south side by Turnhouse Hill, Caernethy and East Side Black Hill; and its western or upper end, is bounded by the crags and cliffs of Habbie's How. Its bottom is very narrow, not being above the sixth part of a mile broad any where in its course. At the base of Castlelaw, the Logan Water changes its direction, and flows in a varying course, but in general in a south-eastern direction, through the hills to Glencross Bridge, where it escapes from the mountain group into the low and flatter country. That portion of the valley

of the North Esk river, which occurs in this group, extends from Cock Rig, where the sources of the river are situated, to Caerlips Bridge, where the Esk flows into the low country. It is narrow and is bounded on both sides by green hills of considerable height: these are Caerlips Hill, Mount Hill, and Cock Rig on the one side, and Spitt Hill on the other.

## Section II.

The rocks of which this portion of the Pentland Hills is composed, belong to the Transition, Flœtz, and Alluvial classes; no fixed rocks of the Primitive class, as far as I know, having hitherto been discovered in any part of the group. The Flœtz rocks, which are by much the most abundant, form the highest, and sometimes also the lowest parts of the group; whereas the Transition rocks in general occur low down; and both set of rocks are more or less covered with Alluvial substances.

We shall now describe these rocks in the order of their relative antiquity, beginning with transition, which are considered as having been deposited before the flœtz and alluvial rocks, and lie deeper in the crust of the earth.

## Section III.

### TRANSITION ROCKS.

The transition rocks which I have had an opportunity of observing in this group of hills, are Clay-Slate, Grey-Wacke, Greenstone, and I believe also Porphyry.

### I. *Clay-Slate.*

The colour of this rock is greenish-grey, or greyish-black; scales of mica are in general intermixed with it, and these give it a glimmering lustre. Its fracture is sometimes fine, sometimes coarse slaty, and in some instances the slaty is associated with a splintery fracture. It is opaque. The streak is grey-coloured. It is soft, inclining to semi-hard; it is easily frangible.

It is distinctly stratified, and the strata run from south-west to north-east, and are nearly vertical.

I did not observe in it either imbedded portions of quartz, or cotemporaneous veins of that mineral; and no felspar, or other imbedded minerals, appear in it. Several of the varieties are nearly allied to Slate-clay, and even appear to pass into it; others again, particularly those ha-

ving a greenish-black colour, appear allied to Com pact Slaty-felspar, because, like it, they decay wi a white crust, are thick slaty, and harder than t grey-coloured varieties. It sometimes appea more or less curved and waved in its structure,— appearance not unfrequent in transition clay-slat and which, like the curved and waved laminæ more regularly crystallized bodies, is to be view as the effect of crystallization.

Hare Hill, as far as I could ascertain, appea to contain much of this rock. It appears also the north-east and south-west corners of Blac Hill, and is frequent in the valley of the Nor Esk river.

## II. *Grey-Wacké.*

The grey-wacke which occurs in our distri is very small granular, and has but little of t mechanical aspect of the common varieties of th rock. It is composed of felspar, quartz, and som times a little mica; and these minerals are so co nected together, as to shew that this rock is a ch mical not a mechanical deposite. It occurs beds varying from a few inches to two or thr feet in thickness, and these alternate with the cla slate already described. I observed it ne Habbie's How, and also in the valley of the Nor Esk river.

### III. *Greenstone.*

This rock presents the usual characters of greenstone. It occurs in beds sometimes twelve feet and upwards in thickness, situated in clay-slate. Neither the greenstone nor clay-slate, where in contact with each other, appear altered or intermixed. Two beds of this rock occur in a quarry of clay-slate above Bevelaw-House.

### IV. *Porphyry.*

Upon the north-eastern extremity of the Black Hill, where the transition clay-slate occurs, felspar-porphyry and felspar-rock make their appearance and these are so connected with the clay-slate, that I cannot help suspecting portions of these rocks may here belong to the transition series.

## Section IV.

### FLŒTZ ROCKS.

The flœtz rocks, of which by far the greatest part of this portion of the group is composed, are the following: Conglomerate, Sandstone,

Clinkstone, Clinkstone-Porphyry, Amygdaloidal Clinkstone-Porphyry, Greenstone, Compact Felspar, Claystone, Claystone-Tuff, and Porphyry.

## I. *Conglomerate.*

This rock is composed of roundish, angular, and other shaped portions of quartz, grey-wacke, grey-wacke-slate, porphyry, felspar, flinty-slate, common jasper, hornstone, and mica. The portions are from the size of a man's head and upwards, to that of a pea, and the larger masses are connected together by a basis or paste of the smaller pieces, and these again are joined together without any basis, just as stones are which have been deposited from a state of chemical solution. It varies in hardness; two principal varieties may be distinguished, a hard and soft. In the hard variety, the basis and the included portions run into each other, and are so crystalline and firmly joined together, that it is only by means of violence that we can break off masses. This variety generally forms the mass of entire strata; at other times we find it intermixed in cotemporaneous portions in the softer variety. The softer variety is so loose in its texture, that we can readily break it with the hammer, and even extract the imbedded portions with the fingers. It occurs, in general, more abundantly, than the hard variety.

The very small granular varieties of this rock, which are principally composed of felspar and quartz, are very nearly allied to the grey-wacke of this district; indeed, in some instances, it is difficult to distinguish the one from the other in single specimens *.

This fact, in conjunction with one about to be mentioned, namely, That clay-slate occurs in conglomerate, goes to support an opinion I have long entertained, that Transition rocks may alternate with the oldest Flœtz rocks; and, therefore, that the rocks of the transition and the flœtz classes are not separated from each other in the manner generally alleged by mineralogists.

The conglomerate is sometimes very small granular, and earthy in its appearance, and then it is compact, and, both externally and internally, is not unlike certain varieties of basalt and wacke. Varieties of this kind occur at the base of Turnhouse Hill, also at Kirk Hill, and in the lower part of the West March Burn. It is distinctly stratified, and coarse and fine granular strata alternate with each other. The strata are in general inclined at angles from 10° to 30°. Thin layers of a variety of greenish-grey coloured clay-slate occur in it.

* If the Grey-wacke of the Pentlands is a chemical deposite, the same must be the case with the Conglomerate rock described in the text.

It rests upon the transition rocks of the district, and occurs in very considerable abundance. It forms the fundamental rock of Turnhouse Hill, Caernethy, East Side Black Hill, the Kipps, Braid Know, Black Hill, Kirk Hill, Castlelaw, the cliffs at Habbie's How; and nearly the whole of Bald Hill, Mucks Rig, Spittal Hill, and the small hills that extend from West Side to Caerlips, are composed of this conglomerate. On the south-west end of Black Hill, it is associated with porphyry and felspar, apparently in beds; but of this I am not perfectly certain, as the cover of debris prevented me examining the relative situation of the rocks with sufficient accuracy.

## II. *Sandstone.*

This rock is generally of a reddish-brown colour, of different degrees of intensity; but some varieties, by the action of the weather, become white or grey. It varies from fine to coarse granular, the latter forming a kind of Sandstone Conglomerate. Its component parts are quartz, felspar, clay, and mica; of these, the quartz is by far the most abundant material. The quartz is of a grey colour, sometimes crystallized, more generally in roundish or angular concretions; the clay is of a reddish-brown colour, and is the substance which colours the sandstone; and the mica oc-

curs in small silver-white scales. I could not discover that these minerals were connected together by any basis; on the contrary, they appear to be associated in the same manner as the felspar, quartz, and mica are in granite. Is it therefore to be considered as a rock deposited from a state of chemical solution? Sandstone, in a general point of view, may be considered as a continuation of the Granite series, and might be denominated *Flœtz Quartz-rock*. It sometimes contains cotemporaneous portions of flœtz-limestone, thus forming a kind of arenaceous limestone-conglomerate. The limestone even appears to form thin and short beds in the sandstone, as is the case in the sandstone rocks above Habbie's How. The limestone is of a grey colour, the fracture is foliated, and it includes cotemporaneous calcareous spar, and variously shaped concretions of compact limestone. Limestones of this kind have been described as brecciated stones, or as composed of fragments: thus, the transition limestones often exhibit this brecciated character, and Brochant, in his valuable paper on Transition Rocks, in the *Journal des Mines* for 1808, maintains, although unsuccessfully, that these limestones are truly brecciated.

Some varieties of the sandstone are not unlike the grey-wacke which occurs near Habbie's How; and consequently closely resemble the fine granular varieties of conglomerate. It is distinctly stratified;

the direction of the strata, south-west and north-east; and the dip varies from 10° to 30°.

It rests upon the conglomerate, as may be observed in the course of the Logan Water above Habbie's How, and appears also to alternate with it, as I infer from the appearances it presents in the conglomerate at the junction of the transition and flœtz rocks, above and a little to the eastward of Bevelaw House.

It skirts the Mid-Lothian portion of the Pentland hills, from the base of the Kirkyetten Hills to the south-west corner of the group, where it rises several hundred feet above the neighbouring country, forming the whole of the East Cairn Hill. It can be traced from the base of the East Cairn Hill, down the course of the Logan Water, to within a few yards of the waterfall at Habbie's How, and it appears to cover a considerable portion of the high muirish flat traversed by the Logan Water.

### III. *Clinkstone, Clinkstone-Porphyry, and Amygdaloidal Clinkstone-Porphyry.*

The clinkstone, when pure, is of a deep greenish-grey colour; but when iron-shot, which is generally the case, it is reddish-brown: the lustre of the principal fracture is glistening, of the cross fracture glimmering: the principal fracture is

slaty, the cross fracture uneven, passing into imperfect and small conchoidal. It is translucent on the edges, hard, brittle, rather easily frangible, and rather heavy.

It is nearly allied to felspar, and is to be observed passing into the compact felspar, which occurs so frequently in the Mid-Lothian portion of the Pentland Hills; it also sometimes inclines to claystone, and in other instances nearly passes into basalt: The darker-coloured varieties, those inclining to basalt, sometimes contain imbedded cotemporaneous portions of quartz, nearly an inch square: and the iron-shot varieties, are sometimes traversed by cotemporaneous veins of lamellar heavy-spar. Crystals of felspar occur frequently imbedded in it, and then it forms *clinkstone-porphyry*, or what is sometimes called Porphyry-slate. The crystals of felspar are sometimes of considerable size, and in certain varieties of this rock, are remarkable for their breadth and thinness. Sometimes the clinkstone-porphyry passes into a kind of felspar-porphyry, as on the west side of Glencross. Sometimes the amygdaloidal porphyry is intermixed with green-coloured sandstone, or the sandstone appears imbedded in the porphyry in the form of fragments: in other instances, we observe the sandstone, which appears to occur in small beds in the porphyry, including what at first sight appear to be fragments of porphyry. This mutual intermixture of the sandstone and porphyry, the gradual passage of the inclosed sandstone into the

porphyry, and of the porphyry imbedded in the sandstone, are proofs, not only of the cotemporaneous formation of these two rocks, but also of the chemical nature of the sandstone. This porphyry is often amygdaloidal, and then it is named *amygdaloidal clinkstone-porphyry* *. The amygdaloidal cavities are more or less completely filled with mineral substances of different kinds: sometimes they are entirely filled with green-earth, or the green-earth merely encrusts the vesicular cavities, and the cavity is filled up with agate. The agate is associated with amethyst, and also with common calcedony, which latter is sometimes stalactitic, and is so circumstanced, as to shew, that although stalactitic in form, it is not so in formation, being rather a crystalline shoot, than a stalactitic deposition. Sometimes the vesicular cavities are filled with a mixture of calcareous-spar, heavy-spar, and brown-spar. The agates and calcedonies are of considerable magnitude, some specimens being several inches square. Some varieties of the rock contain diallage. The porphyritic clinkstone is sometimes tufaceous, as in Glencross, and at first sight

* Some of these varieties are grooved very deeply. These groovings are seen sometimes on the surface of masses, sometimes in their interior, and we observe in this latter case that the grooves fit into each other. I have noticed the bottoms of the beds somewhat convoluted.

appears to be composed of rolled masses of porphyry or clinkstone, contained in a porphyritic basis; but these masses are to be observed passing by imperceptible degrees into the basis, and hence are of cotemporaneous formation with it, and cannot be viewed as fragments.

This rock rests upon the conglomerate; but its immediate relation to the red sandstone, I had no opportunity of ascertaining. It occurs very abundantly throughout the Mid-Lothian part of the Pentlands, but more frequently in the middle part, and the eastern extremity, than in the western. It appears in general rather on a low level, near the foot of the hills; although in particular instances, as at the Kipps and the Kirkyetten Hills, it forms summits upwards of a thousand feet high.

On the outside of the group, it extends from East Side to Kirkyetten, and onwards to Malleny, forming a nearly continuous mass. The smaller hills that skirt the group in this line of direction, are also composed of it; and it is to be seen in the interior of the group in the Logan Water valley, at the foot of Turnhouse, Caernethy, and Castlelaw Hills, where it rests upon conglomerate; and fine sections of it are exposed on both sides of Glencross.

## IV. *Greenstone.*

This is not a frequent rock in the flœtz series of the Pentlands. It is in general small granular, and appears to pass into basalt, and sometimes to form that variety of rock named Basaltic Greenstone. It is at times amygdaloidal, and then it contains calcareous spar and agate. It occurs above the conglomerate at the north-east corner of Turnhouse Hill, and at the base of Black Hill, about a quarter of a mile from Habbie's How. Many rolled masses of a large granular greenstone, along with basalt and amygdaloid, occur in the bottom of the West March Burn, but I did not find any of these rocks *in situ* any where in the course of the rivulet.

This rock appears to be associated with the clinkstone, and probably occurs in beds below, or in it.

## V. *Compact Felspar.*

The colour of this rock, is flesh-red, or brownish-red; sometimes greyish and yellowish-white, and ash-grey and yellowish-grey. It is massive. The lustre is glimmering, and the fracture minute foliated, and splintery, and sometimes conchoidal, sometimes slaty. It is semi-hard and brittle. Specific gravity 2,497 *. Some varieties of the felspar exhi-

* Vid. Mackenzie on Compact Felspar. "Memoirs of the Wernerian Society," vol. *i.* p. 617.

bit a very deep-grooved surface: this is strikingly the case with the felspar of Braid Know. It is sometimes porphyritic, and then it contains imbedded crystals or grains of felspar; sometimes also scales of mica, crystals of augite, and of common quartz, or of rock-crystal. A remarkable variety of this mineral occurs near Habbie's How and other parts of the group, in which beautiful globular concretions of light red-coloured felspar are imbedded in dark-red felspar. These concretions are from one-sixth of an inch, to an inch in diameter. Other globular concretions occur in the felspar; these are composed of concentric lamellar layers of red felspar, and of a green-coloured substance, which is probably very minute granular hornblende, either pure or intermixed with felspar. Both these kinds of concretions are evidently of cotemporaneous formation with the felspar in which they are contained, because they are principally composed of that substance, and exhibit no marks of attrition; on the contrary, are to be observed gradually passing into the surrounding mass. Compact felspar is observed passing, on the one hand, into hornstone, and on the other into claystone. It occurs in beds, and in cotemporaneous masses several feet square in conglomerate, at Habbie's How; and at the same place, it appears to rest on transition clay-slate.

It occurs abundantly in Black Hill, Bield Hill, Kirk Hill, Capelaw, and Castlelaw, where it is more or less frequently associated with claystone. It also occurs, but less frequently and abundantly,

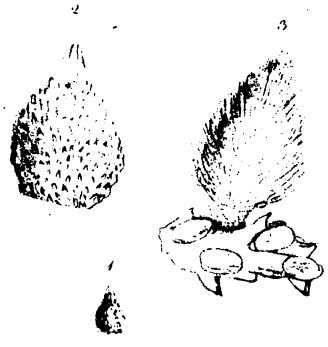
in the Kirkyetten Hills, Turnhouse Hill, Caernethy, East Side Black Hill, and Braid Know.

## VI. *Claystone.*

The principal colours of this mineral, are grey, blue and red; and it frequently exhibits dendritic delineations. Its fracture is earthy and dull. It is opaque; soft; rather brittle. Rather easily frangible. Feels meagre and rough. Does not adhere to the tongue. Rather heavy.

It is stratified. It passes into compact felspar. Sometimes portions of the claystone appear harder than the usual varieties, and these are passing into compact felspar: when they are imbedded in the common earthy claystone, the mass appears as if conglomerated or brecciated, and this appearance is rendered more evident when the basis is of a different colour from the harder portions. These harder portions vary in shape and size, being sometimes angular, sometimes more or less rounded, and from the size of a pea to that of a man's head and upwards. Appearances of this kind have been considered as proofs of the mechanical nature of the mass; but the circumstance of these imbedded portions passing imperceptibly into the surrounding mass, and of the uninterrupted transition, from the distinctly formed concretion, to the mere tendency to this form, joined to the occurrence of this harder claystone in cotemporaneous veins in the mass, prove

Wern. Mem. Vol. II. P. 96.




F. Mitchell. Sc.

hat it is entirely of a chemical nature. Sometimes
: has still more of the fragmented appearance,
hen it forms *claystone-tuff*, a rock to be described
fterwards. It rests upon claystone-tuff; is fre-
uently intermixed with it, and probably alter-
ates with it. It passes into *porphyry*, a rock
hich rests upon it; and is intimately related to
ompact felspar, into which it passes, and in which
: is probably contained in beds.

On the north-east, south, and south-west accli-
ties of Turnhouse Hill, where the line of junc-
on can be discerned, it is to be observed resting
on claystone-tuff, and as far as I could ascertain,
ver below or alternating with the clinkstone-
rphyry. In this hill, its line of junction with
e clinkstone varies much in height: in some
stances, as on the eastern, and north-eastern foot
the hill, being almost washed by the Logan Wa-
r; but more frequently it is far above the level
the river, several hundred feet above the bottom
the valley. It occupies nearly the same general
gh level in Caernethy and East Side Black Hill;
d on the north side of East Side Black Hill, I saw
resting on claystone-tuff, which appears to rest on
inkstone-porphyry. From East Side Black Hill,
ong the western or upper end of the valley of
ogan Water, it does not appear until we pass
ogan Water, when numerous fragments of it are
be observed on the west side of the valley, lead-
g from Habbie's How north-east towards Be-
law, where it appears to be associated with com-

pact felspar. From this valley, it may be traced more or less uninterruptedly along Black Hill, Kirk Hill, and Castlelaw, and onwards to the Kirkyetten Hills, where it forms a considerable portion of the striking rocky face named Kirkyetten Craig. In the whole of this course, it is associated with compact felspar.

## VII. *Claystone-Tuff.*

This rock is composed of claystone, in which are included apparent fragments, of various sizes and shapes, of claystone, porphyritic-claystone, conchoidal-hornstone, porphyritic-hornstone, compact felspar, and red flint. It is sometimes traversed by veins of conchoidal-hornstone and porphyry; and these, as well as all the different kinds of fragments, are of cotemporaneous formation with the claystone basis *. The conchoidal-hornstone sometimes assumes a slaty appearance, and passes into striped jasper: it also passes into claystone, compact felspar, and into flint. Both the claystone and the conchoidal-hornstone are sometimes beautifully dendritic.

It appears in some instances to rest on conglomerate, sometimes on clinkstone-porphyry, and is

* It is evident that the formation of trap-tuff must also be chemical.

frequently covered with claystone. The finer granular varieties, gradually pass into claystone; and probably it is contained in great cotemporaneous portions in the claystone, or alternates in beds with it.

It occurs in Turnhouse Hill, Caernethy, East Side Black Hill, Kirk Hill, Castlelaw, and the Kirkyetten Hills, and in general it is situated on a higher level than the clinkstone.

## VIII. *Porphyry.*

The basis of this rock varies in colour from grey, through blue to red. The fracture is earthy and dull. It is opaque, soft, sectile, rather easily frangible, and rather heavy; so that it appears to be nearly of the same nature as claystone. It contains imbedded crystals of felspar, which are generally small, almost always in a soft or disintegrated state, and in the bluish varieties nearly in the state of steatite. It passes on the one hand into claystone and compact felspar, and on the other it inclines to basalt and clinkstone.

It rests on claystone, and is frequently intermixed with it. It forms the higher parts of Turnhouse Hill, Caernethy, East Side Black Hill, Castlelaw, and occurs also in Kirk Hill, Black Hill, and amongst the Kirkyetten Hills.

## Section III.

### ALLUVIAL ROCKS.

The alluvial substances are few in number, of little extent, and do not present great variety in appearance: they are, Rolled Masses, Gravel, Clay, and Peat.

### I. *Rolled Masses.*

These are generally portions of the neighbouring rocks, which have been broken off by the influence of the weather, and rolled in the water of the rivers and rivulets of the district. Amongst these, however, I observed several large masses of what may be named *primitive grey-wacke*, and which is foreign to this part of the country; its nearest native place being near Dunkeld in Perthshire. Similar masses occur in different parts of Mid-Lothian; also in Fifeshire. How have they been transported to their present situation?

### II. *Gravel, Sand, and Clay.*

The gravel, sand, and clay, are portions of the rocks of the district, more or less completely bro-

ken down, and intermixed together. They are spread over the bottom of the valleys, and sides of the hills; but not in equal quantity, for the gravel and sand are more abundant than the clay.

### III. *Peat.*

This well known substance, occurs in considerable abundance in different parts of the district, but does not present any peculiar appearance.

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I hope, on a future occasion, to be able to extend my inquiries to the western portion of the Pentlands, and to accompany the description of that part of the group with a map of the whole range, and a more particular description than that which I now lay before the Society, of the Mid-Lothian division.

In all true conglomerated rocks, the fragments of which they are composed, are either water-worn, or present distinct fractured surfaces; they are not intermixed at their edges with the basis in which they are contained; we do not observe the substance of the fragment gradually passing into that of the basis, and we never see the basis by a series of gradations assuming the form of fragments. Such appearances, however, occur in rocks having a conglomerated aspect, but which appear to have been deposited from a state of chemical solution. These characters, therefore, when taken in conjunction with other geognostic relations, afford us the means of distinguishing true conglomerated rocks from such as are probably only so in appearance.

The following short examination of the particular characters exhibited by certain conglomerated rocks, will afford us proofs of the plausibility of the opinion just stated, viz. that many conglomerated rocks are chemical deposites.

In the conglomerated gneiss, mica-slate, and granite, the imbedded masses are only apparent, not true fragments; for, upon examining them, we do not find either water-worn or fractured surfaces; on the contrary, they are intimately mixed with the basis at their junction with it; and they are observed passing into it in so gradual and imperceptible a manner, that we cannot say where the one begins and the other terminates. The same is the case with the conglomerated rock which ac-

companies primitive porphyry, and with the verd antique or brecciated primitive limestone. Hence these rocks are to be viewed as chemical deposites, and as they are the only primitive rocks exhibiting the fragmented aspect, we are entitled to infer, that, as far as we know at present, true conglomerates do not occur in primitive country.

*Grey-wacke*, the next conglomerated rock we described, has been hitherto considered as a mechanical deposite. But the fragments in this, as in the rocks already described, are to be observed gradually passing into the surrounding mass, and intermixed with it at their line of junction, and apparent fragments of grey-wacke-slate, several feet in length and breadth, and not more than one-twelfth of an inch in thickness, which must have been broken into pieces, had they been true fragments, are imbedded in the grey-wacke. Further, the constituent parts of the rock are frequently connected together without any basis, in the same manner as the felspar, quartz, and mica in granite; and we also observe the ingredients concentrating in the basis into roundish and other shaped distinct concretions. These facts go to support the opinion, that grey-wacke is a chemical not a mechanical deposite.

In the conglomerated transition limestone, which has excited so much attention amongst mineralogists, the fragments have the same characters as those in grey-wacke, conglomerated gneiss, &c., and are therefore to be considered of cotempo-

## XIV. *On Conglomerated or Brecciated Rocks.*

By Professor Jameson.

*(Read 4th December 1813.)*

All the rocks included under this general head, are supposed by mineralogists to be *mechanical* deposites, and are said to be composed of fragments of different kinds, more or less intimately joined together by means of a ground or basis. It is the object of the present paper to point out the mineralogical relations of these rocks, and to shew that certain varieties of them are *chemical*, not mechanical, deposites.

### Section I.

#### MINERALOGICAL RELATIONS OF CONGLOMERATED OR BRECCIATED ROCKS.

Conglomerated rocks occur in Primitive, Transition, and Flœtz country.

## I. Primitive Conglomerated Rocks.

The primitive conglomerated rocks occur in beds or strata of considerable magnitude, in Gneiss, Mica-Slate, Granite, Porphyry, and Limestone.

### 1. *Conglomerated Gneiss.*

The gneiss conglomerate, is formed of roundish and angular fragments, or portions of gneiss, hornblende-rock, felspar, and quartz, connected together by a ground or basis of gneiss. Sometimes the whole bed has the conglomerated character; in other instances, only a part of it is in this state; the other portion, and frequently the largest, being of pure gneiss. This rock occurs near the Castletown of Braemar in Aberdeenshire, at Valorsine and St Bernard in Switzerland, and also amongst the mountains of Norway, as appears from the following description by Von Buch: "The interior of the rocks is here not less remarkable. At first, the quartz continues from Formo onward. It then frequently resembles porphyry; for there are imbedded in the grey-coloured quartzy basis, dark crystals of quartz, and the rock is almost every where intersected by *drusy* fissures. At length, about half a German mile from Formo, the gneiss also makes its appearance in the valley, and the quartz rocks disappear. The gneiss rises immediately to a great thickness. The Rosten-

berg commences immediately after its appearance, as well as the ravine towards Lessöe; and in these straits, it becomes very remarkable. It generally abounds in mica; the mica is not scaly-foliated, but in considerable folia, which are continuous, and it abounds with beds of quartz. But there is also every where considerable pieces of gneiss dispersed through it, in which the felspar predominates; the mica only appears in separate isolated folia, and the quartz very sparingly. The mica in these pieces, forms more straight and parallel running streaks, than slate; while, on the other hand, the slaty composition in the surrounding gneiss is more strongly marked and distinct. These pieces are all angular, and most of them even are quadrangular; of so considerable a magnitude, as a foot and upwards, and they appear, in fact, very thickly heaped together; but still in such a manner, that we always distinguish the connecting gneiss mass or ground. The streaks of the different pieces lying near each other, are often parallel, but they also frequently take completely different directions. They do not consequently follow the direction of the slaty structure of the gneiss which constitutes the basis. This wonderful rock is not a conglomerate, the pieces being too small. The basis is too distinct, and too strongly characterised as gneiss. But it must be owned, that this appearance bears some resemblance to the manner in which the puddingstone is found in gneiss at Valorsine, and in the lower Vallais, according

to Saussure :—an older gneiss which was destroyed in the period of the formation of the newer *."

### 2. *Conglomerated Mica-Slate.*

The second kind of conglomerated primitive rock, is that which occurs in mica-slate. It is composed of variously-shaped portions of quartz and sometimes of mica-slate, imbedded in a basis of mica-slate. It occurs in the country between Dunkeld and Mullenæarn in Perthshire; and many years ago I saw a variety of this rock in Fetlar, one of the Zetland Islands, as mentioned in the second volume of my "Mineralogical Travels."

### 3. *Conglomerated Granite.*

This rock occurs principally in the newer granite formations. It is composed of portions of granite, gneiss, mica-slate, quartz, and felspar, imbedded in a basis of granite. This granite rests upon clay-slate or other older primitive rocks. It occurs in Saxony and other countries on the Continent; and a conglomerated granite, although probably of a different formation from the Saxon, occurs in the Grampians.

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* Von Buch's "Travels in Norway and Lapland." Black's translation, p. 94. and 95.

of granular limestone appear imbedded in compact limestone.

### III. Flœtz Conglomerated Rocks.

The conglomerated rocks of the flœtz class, are, Sandstone-Conglomerate, Sandstone, and Trap-Tuff.

#### 1. *Sandstone Conglomerate.*

This rock is composed of rounded and angular pieces of granite, gneiss, mica-slate, clay-slate, porphyry, grey-wacke, felspar, jasper, quartz, &c. varying in size from that of a pea, to much above that of a man's head. These fragments are connected together by means of a basis composed either of iron-shot clay, quartz, or of smaller fragments of the same nature as the larger.

It usually occurs resting upon transition rocks, sometimes also lying on primitive rocks. It is a frequent rock in this country.

#### 2. *Sandstone.*

This rock is principally composed of quartz, which is either in roundish or angular grains, or more or less regularly crystallized: it is seldom pure, more generally it is intermixed with scales

### 1. *Grey-Wacke.*

This rock is composed of pieces of clay-slate, grey-
ıcke, flinty-slate, felspar, and quartz, imbedded
a basis of the same materials, or a basis of clay-
ıte. The pieces or apparent fragments vary in
agnitude, from that of a pea, to much above that
a man's head. It is distinctly stratified, and
ternates with clay-slate, limestone, and other
cks. It abounds in the alpine country, to the
rth and south of the Firth of Forth.

### 2. *Sandstone.*

This rock is composed of grains of quartz, seldom
ceeding a pea in size, connected together with-
ıt any basis, just as quartz concretions are in
ica-slate and quartz rocks.

### 3. *Limestone.*

Conglomerated limestone rocks are not uncommon
ı transition country. They at first sight appear to
e composed of fragments of limestone, imbedded
ı a limestone basis or ground. Sometimes por-
ions of compact limestone appear imbedded in
ranular limestone; in other instances, portions

In all true conglomerated rocks, the fragments of which they are composed, are either water-worn, or present distinct fractured surfaces; they are not intermixed at their edges with the basis in which they are contained; we do not observe the substance of the fragment gradually passing into that of the basis, and we never see the basis by a series of gradations assuming the form of fragments. Such appearances, however, occur in rocks having a conglomerated aspect, but which appear to have been deposited from a state of chemical solution. These characters, therefore, when taken in conjunction with other geognostic relations, afford us the means of distinguishing true conglomerated rocks from such as are probably only so in appearance.

The following short examination of the particular characters exhibited by certain conglomerated rocks, will afford us proofs of the plausibility of the opinion just stated, viz. that many conglomerated rocks are chemical deposites.

In the conglomerated gneiss, mica-slate, and granite, the imbedded masses are only apparent, not true fragments; for, upon examining them, we do not find either water-worn or fractured surfaces; on the contrary, they are intimately mixed with the basis at their junction with it; and they are observed passing into it in so gradual and imperceptible a manner, that we cannot say where the one begins and the other terminates. The same is the case with the conglomerated rock which ac-

companies primitive porphyry, and with the verd antique or brecciated primitive limestone. Hence these rocks are to be viewed as chemical deposites, and as they are the only primitive rocks exhibiting the fragmented aspect, we are entitled to infer, that, as far as we know at present, true conglomerates do not occur in primitive country.

*Grey-wacke*, the next conglomerated rock we described, has been hitherto considered as a mechanical deposite. But the fragments in this, as in the rocks already described, are to be observed gradually passing into the surrounding mass, and intermixed with it at their line of junction, and apparent fragments of grey-wacke-slate, several feet in length and breadth, and not more than one-twelfth of an inch in thickness, which must have been broken into pieces, had they been true fragments, are imbedded in the grey-wacke. Further, the constituent parts of the rock are frequently connected together without any basis, in the same manner as the felspar, quartz, and mica in granite; and we also observe the ingredients concentrating in the basis into roundish and other shaped distinct concretions. These facts go to support the opinion, that grey-wacke is a chemical not a mechanical deposite.

In the conglomerated transition limestone, which has excited so much attention amongst mineralogists, the fragments have the same characters as those in grey-wacke, conglomerated gneiss, &c., and are therefore to be considered of cotempo-

raneous formation with the limestone in which they are contained, and consequently, the whole mass is to be viewed as a chemical formation.

The sandstone-conglomerate has much more of the mechanical aspect than any of the rocks we have at present described. Indeed, its general appearance is so much that of a mechanical deposite, that I long hesitated as to its true nature, and it was only after minute and careful investigation I was induced to believe, that some varieties at least of this rock are of a chemical nature. This opinion, I started in my sketch of the Mineralogy of the Pentlands, read before the Society some time ago, and still find no reason to alter it. One of the best examples of the chemical sandstone-conglomerate in this neighbourhood, is that at Habbie's How in the Pentlands. This conglomerate, as is mentioned in my description of the Pentland Hills, is composed of variously-shaped masses of grey-wacke, grey-wacke-slate, flinty-slate, felspar, jasper, and quartz, immersed in a basis composed of smaller fragments, generally of the same minerals as the larger. The most abundant of these apparent fragments, are those of grey-wacke, which have generally a globular or oval form, and vary in size, from a walnut to that of a man's head and upwards. They are composed of felspar, quartz, and a little mica, which are connected together without any basis, or have the same mode of aggregation as that observed in crystalline rocks, such

as granite and syenite. The basis in which these apparent fragments are contained, is of the same nature with the fragments themselves, and it therefore is also of a crystalline nature. But it may be said, that these apparent fragments are in reality true fragments imbedded in a crystallized basis; but this cannot be the case, because they do not exhibit water-worn or fractured surfaces, and are to be observed passing by imperceptible degrees into the substance of the basis in which they are immersed. A further proof of the truth of the opinion now stated, is afforded by the appearance which the basis itself at times assumes. Thus, we sometimes observe the ingredients of the basis concentrating into indistinct globular masses, which are harder than the general basis; and, in other instances, the concentration of the parts, is still more distinct, and the globular concretions thus formed, are so strongly marked, as not to be distinguishable from the large apparent fragments.

*Sandstone*, another of the conglomerated rocks we described, is in general supposed to be sand agglutinated by means of a clayey, calcareous, or quartzy basis, and hence it is said that all sandstones are mechanical deposites. This opinion, I suspect, is not correct, because appearances in several of the sandstones of this country, seem to intimate, that these, at least, are more of a chemical than of a mechanical nature. These sandstones, when examined with the glass, appear to

be composed sometimes of crystallized quartz, connected together without a basis, sometimes of quartz in angular or roundish concretions also joined together without a basis. The quartz is sometimes intermixed with concretions or crystals of felspar, and these appear imbedded in the quartz in the same manner as grains and crystals of felspar are in porphyry or granite; and mica occurs in these rocks in the same mineralogical relations. These sandstones, then, do not differ from granite or porphyry in structure, and therefore are to be considered, like them, as chemical formations, or as having been deposited from a state of chemical solution. Other sandstones are entirely composed of quartz in granular distinct concretions, and these are sometimes so pure, that they might in single hand-specimens be confounded with primitive granular quartz. If, then, primitive granular quartz be a chemical deposite, of which there cannot be a doubt, certainly this sandstone must also have been deposited from a state of chemical solution. But this beautiful and highly crystalline quartzy sandstone alternates in beds with that variety of sandstone which resembles the common building sandstone of this vicinity; it even occurs in the same stratum or bed with it, and there is an uninterrupted transition from the one into the other; if, therefore, the quartzy sandstone be a chemical deposite, the same must be the case with the common building sandstone. The occurrence of a clayey or marly basis

in the sandstone, does not affect the plausibility of the opinion here stated. Sandstone sometimes occurs in globular and concentric lamellar concretions, and in cotemporaneous veins, in sandstone and trap rocks; also in kidneys, in slate-clay, amygdaloid, and other rocks, appearances expressive of the crystalline nature of the sandstone, because they occur only in granite, greenstone, and other crystalline rocks. If, then, the opinion just stated in a very general way, shall prove correct, it will afford us an easy explanation of all the varieties of curvature, hardness, and position, observed in sandstone strata; and the alternation of sandstone with limestone, trap, and other rocks, will no longer be difficult of explanation.

*Trap-tuff*, the last conglomerated rock we enumerated and described, is generally supposed to be entirely a mechanical deposite; but I am inclined to view it more as a chemical than a mechanical formation. This opinion, I stated in my account of the Pentland Hills; and the following are some of the facts that still induce me to consider it as the most plausible explanation of the mode of formation of that rock.

1. The masses of basalt, amygdaloid, felspar, and of other trap rocks contained in the tuff, are to be observed gradually passing into the trap basis in which they are contained.

2. Cotemporaneous veins of basalt and amygdaloid traverse the tuff *.

3. The tuff itself sometimes occurs in globular concretions, and these concretions are again composed of curved lamellar concretions.

4. Some varieties of tuff, like basalt and greenstone, are entirely composed of globular distinct concretions.

5. Cotemporaneous veins of tuff traverse it in all directions.

6. Cotemporaneous veins, partly of the nature of tuff, partly of the nature of basalt, occur in the tuff.

7. The masses of basalt and other rocks in the tuff, are sometimes of such an enormous size, and so constructed of easily separable concretions, as to banish every idea of their being rolled fragments.

8. Lastly, The quantity of mechanical intermixture, is in general inconsiderable, and it is principally composed of fragments of primitive, transition, and older flœtz rocks.

From the preceding descriptions and observations, it follows, that the quantity of mechanical mineral matter in the crust of the earth, is far less considerable than has been generally supposed.

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* These veins agree in so many characters with the veins of basalt, porphyry, granite, pitchstone, &c. usually considered of after-formation, that I am inclined to view many of these also as of a cotemporaneous nature.

## XV. *On Porphyry.*

By Professor Jameson.

*(Read 14th December 1811.)*

According to Werner, there are five different kinds of porphyry, viz. clay-porphyry, hornstone-porphyry, pitchstone-porphyry, obsidian-porphyry, and pearlstone-porphyry; all of which occur in Primitive country, and either in a conformable or unconformable and overlying position *. He does not enumerate in his system of rocks any Transition porphyry; and in the Flœtz class, the only rock that can be considered as appertaining to this species, according to the Wernerian view, is his Porphyritic-stone, or Porphyritic claystone.

* I may here remark, that it is not improbable that some porphyries described as overlying, are not so in reality, being merely conformable beds cut into variously-shaped masses by the action of the weather; and these, when viewed in particular directions, appear to be uncomformable and overlying.

In the third volume of my System of Mineralogy, and in my Mineralogical Travels, I have shewn, that several of Werner's Primitive porphyries, occur in this country, and shall now prove, that we also possess Transition and Flœtz porphyries.

The *transition porphyries* have either a claystone or felspar basis, and, besides crystals of felspar, they sometimes also contain grains and crystals of quartz, scales of mica, and crystals of hornblende. They occur in beds which are from two to twelve or fifteen feet in thickness, of great extent, and alternate with grey-wacke and transition clay-slate. I first noticed these rocks in the year 1804, during my examination of the county of Dumfries, but hesitated introducing them into the system as porphyries, until I should have an opportunity of examining them more particularly, and in other parts of Scotland where I might find them still on a greater scale, and more distinctly characterized. Last summer, during my stay in Dumfriesshire and Galloway, I paid particular attention to these rocks, and convinced myself that they are true Porphyries, and belong to the Transition class.

In the tract of mountainous country which extends from Langholm by Eskdalemuir and Whamphry, the district where I first noticed these porphyries, the beds are but a few feet thick, and cannot be traced far owing to the cover of soil and grass. They are contained in grey-wacke. In the mining

district of Leadhills, which is situated in transition rocks, I observed several beds of felspar, and some of claystone-porphyry. In the great tract of transition country which extends from New Galloway to Dumfries, there are beds of transition porphyry that alternate with grey-wacke, grey-wacke-slate, and transition greenstone. At Fassney Burn in East-Lothian, transition porphyry is associated with transition granite and syenite. These porphyries also occur in the transition rocks that occur so abundantly to the north of the Frith of Forth.

The *flœtz-porphyries*, like those of the transition class, have a basis of felspar, or of claystone; and contain, besides crystals of common felspar, also crystals of glassy felspar and of common quartz, sometimes almost passing into rock-crystal. They occur in beds, often of great magnitude, that alternate with the first or old red sandstone, or in vast mountain masses resting on that rock. They sometimes also appear in veins of great width, seventy feet and upwards, and of great extent, that traverse this sandstone.

Flœtz clay-porphyry occurs abundantly in the Island of Arran, in the form of mountain masses, beds, and veins, connected with the old red sandstone of that island. Flœtz felspar-porphyry occurs resting upon sandstone, in the islands of Raasay and Skye, and in the Ochil and Pentland Hills. Flœtz pitchstone-porphyry, and flœtz pitchstone occur in beds alternating with clay-porphy-

ry and red sandstone in the island of Arran, and frequently in the form of veins traversing the sandstone.

I have given an account of the occurrence of porphyry in flœtz country, in my Description of the Island of Arran, published in the year 1798, and in my Mineralogical Travels published in the year 1800. In my System of Geognosy, published in the year 1808, I do not introduce the Flœtz Porphyries into the Wernerian arrangement of rocks there explained, because I was not then convinced of the accuracy of my early observations. Having again visited Arran, and re-examined the appearances described in my early writings, I find that they are correct; and, therefore, do not now hesitate to consider Porphyry as a member of the Flœtz class.

## XVI. *Mineralogical Observations and Speculations.*

By Professor Jameson.

*(Read 8th January 1814.)*

### I. *On Stratification.*

The matter of which the solid part of the Earth is composed, is of a metallic nature, and is more or less oxidized. During its formation, oxidation, and combination, great degrees of cold, and also intense degrees of heat, were probably induced, and these latter may have occasioned fusions, &c., somewhat resembling those caused by volcanoes. This matter appears to have been formed in a determinate and regular order, in the form of tabular masses or strata, which are to be considered as bearing the same relation to the Earth, as the folia of crystals do to the crystals in which they occur. These strata are not irregularly disposed: on the contrary, it is highly probable that they are so arranged, that when viewed in the great scale

they will be found to meet under determinate angles, just as folia do in crystals *.

The strata, according to this view, are to be considered as the *cleavage* of the earth; and consequently their formation must have been more simultaneous than is generally supposed. The prevailing opinion in regard to the formation of strata, is, that each stratum is a separate deposite; that the strata are distinctly separated from each other by what are termed the Seams of Stratification; and that cotemporaneous veins never pass from one stratum into another. But the following considerations induce me to call in question the accuracy of this opinion, and incline me rather to believe in the more simultaneous formation of strata.

1. The seams of the strata, or those lines which are said in all cases to mark the boundaries of a stratum, do not always continue throughout the whole mountain range; on the contrary, we sometimes find seams of several strata terminating in the substance of a larger stratum, and these again in the substance of a still larger stratum, in this way exhibiting nearly the same characters as those observed in the seams of the distinct concretions of crystalline rocks of the trap and por-

* As the true figure of the earth is still unascertained, may we not conjecture from what is already known, that it is a polyedron, and that the strata under determinate angles form the sides and cleavage of this great crystal?

phyry series. But these strata-seams are almost always parallel with the slaty structure of the rock, so that, when they disappear in slaty rocks, the direction and dip of the rock may be ascertained by attending to the position of the slaty structure. It would appear from this statement, that the seams of the strata are in many cases to be viewed as particular separations effected in the crystallizing substance, of the same nature, but on a larger scale, than the seams in the distinct concretions, or the laminæ of the slaty structure *.

2. In primitive country, an uninterrupted transition is to be observed from granite to clay-slate, in such a manner that the great masses are to be considered as principal formations, and the smaller as subordinate formations; and these are so connected by intermixture and gradations, that we can say of any two contiguous portions of rock, whether separated by strata-seams or not, that they are of cotemporaneous formation; thus, any two contiguous portions of granite, of gneiss, or of gneiss and granite, or of gneiss and mica-slate, are of cotemporaneous formation.

* In horizontal strata of sandstone and other rocks, we sometimes observe the slaty structure at right angles to the direction of the stratum: if, then, the slaty structure, and the strata seams are but varieties of the same character, it follows, that vertical strata have not been in general elevated into their present situation by a force acting after their formation, but are in their original position.

3. Cotemporaneous veins, which in every theory are supposed to have been formed at the same time with the rock in which they are contained, are to be observed passing through several different strata or beds, as through granite and gneiss, or through basalt, amygdaloid, wacke, and trap-tuff, thus proving that these strata or beds are of simultaneous formation, or that no cessation of the process of deposition took place after the formation of each of the individual rocks.

4. Beds of mountain rocks, as of granite in gneiss, are so connected with the surrounding strata, that we cannot hesitate in considering them as illustrative of the simultaneous formation of strata in general. Thus, these beds are sometimes of considerable extent, and terminate in every direction in the rock in which they are situated, and are so intermixed at their meeting or line of junction that it is difficult to say where the one begins and the other ends. Here, it is evident, that the granite of the lowest part of the bed is of cotemporaneous formation with the immediately subjacent gneiss; that the granite of the uppermost part of the bed is of cotemporaneous formation with the gneiss immediately above it; and that the granite of the great portion of the bed has been formed at the same time with the bounding gneiss. In other instances, these beds are of great thickness, and send out from them veins of granite in all directions into the surrounding rock.

5. Certain appearances in trap rocks are illustrative of the simultaneous formation of strata. In these rocks, we sometimes observe small imbedded portions of limestone and slate-clay, so intermixed with trap, as to prove their cotemporaneous origin with it: in other instances, the limestone and slate-clay appear in the form of small layers, alternating with each other, and fairly included in the trap: and I have observed in some districts, beds of limestone, slate-clay, and clay-ironstone, alternating with each other, and of considerable extent; and all of them fairly included in an immense bed of trap. The quartzy sandstone which so often accompanies trap rocks, presents similar appearances with the limestone, &c. just mentioned. Other formations, as I shall particularly explain in a future communication to the Society, present the same remarkable appearance of series of strata being contained in one great stratum or bed, or in a series of strata of one species of rock. In the cases just stated, trap, limestone, slate-clay, and clay-ironstone strata, have been formed at the same time; but the limestone, slate-clay, and clay-ironstone, being included in the trap, bear the same relation to it, that crystals of quartz do to the basis in which they are imbedded, or cotemporaneous portions of gneiss to the granite in which they are contained.

5. In mica-slate, also in clay-slate, we observe cotemporaneous kidneys of quartz, from a few inches to many fathoms in extent: frequently these masses have an elongated form, and at length, by a series of gradations, become tabular; in which form, they are to be considered as cotemporaneous veins, formed without any previously existing fissure. Similar appearances occur in trap rocks, where cotemporaneous kidneys and veins of greenstone occur in greenstone; and cotemporaneous kidneys and veins of basalt occur in trap-tuff.

6. In some veins, even in those of a metalliferous nature, the seams of the strata are not interrupted by the vein, but fairly cross it. This fact is also in support of the opinion of the formation of cotemporaneous veins without any previously existing rent.

7. Cotemporaneous veins frequently cross each other. This fact may be alleged as a proof in favour of the opinion of these veins having been formed successively, and in open fissures. But if these veins have been formed in the manner of crystals, the crossing may be accounted for on the same principle as that used for explaining the crossing observed in groups of crystals. If this mode of explanation should be thought satisfactory, then it would follow, that the different venigenous, metalliferous and stony formations in a district, may be of cotemporaneous formation.

8. Cotemporaneous veins are observed to occasion shifts in the veins they cross. This also is a

fact which might be stated as inconsistent with the idea of these veins having been formed without previously existing rents, if we did not know that similar shifts occur in cotemporaneous groups of crystals.

9. Some cotemporaneous veins are crossed in part of their course by a portion of the stratified matter in which they are contained: thus, veins of granite or gneiss are crossed by portions or thin beds of the gneiss. This fact is illustrative of the formation of veins without previously existing rents. Similar appearances occur in crystals, as in those of schorl and tremolite. The metalliferous veins in the Derbyshire limestone, which are frequently interrupted by beds of trap, are probably appearances of the same kind.

## III. *On Coal.*

The generally received opinion in regard to the formation of this substance, is, that it is vegetable matter more or less changed by natural processes but little known to us. But the occurrence of coal in primitive country, where no organic remains have hitherto been discovered, and the particular geognostic relations of this mineral, incline me to believe, that glance-coal, and also black-coal, are original chemical deposites, as little connected with vegetable remains as the shells, &c. in limestone, are with the limestone in which they are

contained; but that brown-coal is formed from vegetable remains. The following facts countenance the opinion just stated:

1. Glance-coal occurs in primitive country, in gneiss, mica-slate, and clay-slate, and is so associated with these rocks, as to be of cotemporaneous formation with them.

2. Glance-coal occurs also in transition rocks, where it is sometimes associated with vegetable remains, but these are few in number, and of but rare occurrence, and evidently bear the same relation to the coal which the petrifactions of shells and corals, in the transition limestone, bear to the limestone in which they are contained.

3. Glance-coal occurs also in flœtz rocks, and is accompanied with more vegetable remains than in transition country, just as the shells in flœtz-limestone are more numerous than in transition limestone.

4. Black-coal occurs only in flœtz country, and there it is frequently associated with vegetable remains; but these do not bear a greater proportion to the coal than the shells, &c. in flœtz-limestone bear to the limestone.

5. Black-coal occurs in veins, and these are of cotemporaneous formation with the basaltic or sandstone rocks in which they are contained;—a fact, which proves, that, in this instance at least, coal is an original formation unconnected with vegetable remains.

6. Black-coal occurs in concentric lamellar concretions,—a character which points out its crystalline nature.

7. Some varieties of black-coal appear to have a determinate form, thus indicating their deposition from a state of solution.

8. The vegetable origin of brown-coal is shewn by its whole mass being either entirely composed of vegetable remains, or by those remains occurring in it in a preponderating quantity.

## XVII. *Observations on the Natural History of the Colymbus Immer.*

By Dr Arthur Edmondston.

*(Read 27th April* 1811.*)*

The natural history of the Ember or Imber Goose, is but imperfectly known, and the place of its breeding, and whether it can fly, have been the subject of much speculation. I shall relate a few facts respecting this bird, the accuracy of which, as they are the result of personal observation, may be depended upon.

The imber varies in size and weight according to its age. The full grown bird measures often four feet and nine inches from the tip of one wing to that of the other, and three feet from the point of the beak to the extremity of the tail. The weight too, varies from seven to ten, and even

twelve pounds. The upper part of the plumage is of a bluish-black colour, and the feathers being edged with white, the whole has a speckled appearance. The under-part of the neck, breast, and belly, are of a silvery whiteness, but a dark-coloured bar crosses the vent. There is scarcely any difference of plumage in the sexes, but I think the male is the larger bird of the two.

The imber possesses great strength, swims with amazing rapidity, and is capable of remaining a long time under water; when it dives, it moves by its feet only, and I have known it in this manner, to traverse a space of more than 200 yards, without performing a single respiration. It feeds entirely on fish. The note is wild and melancholy; and when wounded, and in dread of being taken, it utters a cry not unlike to the human voice.

In the month of November, the imber geese are frequently met with in the bays in the Zetland Islands, in small flocks of four, five, and six, but the individuals composing them seldom approach close to one another. Afterwards they associate in pairs; and in the middle of winter and spring they are commonly met with singly. From the middle of summer to the end of autumn, they are rarely seen, and this is the time when it would appear they leave the country for the purpose of propagating and rearing their species. The circumstances of this bird being said never to fly, nor to be met with on shore, have given

rise to the whimsical notion that it hatches its eggs under its wings.

I had long thought that the colymbus immer was a migratory bird, and that, therefore, it necessarily must fly; but being a most perfect diver, that it never had recourse to its wings, unless when some urgent instinct induced it to employ them. Indeed, I had often seen birds which I took to be imber-geese, fly, and nothing but the prevailing belief to the contrary led me to suppose that I might be mistaken. Lately, I had an opportunity of ascertaining the truth of a part of this opinion. On the 31st of January 1811, I saw an imber-goose in Bressa Sound, and after a good deal of trouble, I got sufficiently near to fire at, and wound it. Immediately after receiving the shot, it dived, but in a few minutes thereafter, it came to the surface, raised itself with great ease from the water, and flew with rapidity above 100 yards from the place from which it rose; when, exhausted by the loss of blood, it fell, and was soon after laid hold of. When on wing, I observed it to droop the head and tail a little, in the manner that the Colymbus septentrionalis does. I have sent the skin, imperfectly stuffed, to the Society, and the following is a description of the bird:

It measured two feet seven inches and a half from the point of the bill to the extremity of the

tail; and four feet five inches between the tips of the wings. Its weight was seven pounds and a half. The bill is straight, pointed, very strong, and measures four inches from the side of the mouth to the extremity. The upper mandible projects a little beyond the under one, and is black on its superior ridge. The under mandible is of a light blue colour. The nostrils are placed near the base of the upper mandible, and are divided near the middle by a cartilaginous kind of bar, which arises from the upper, and goes across, but is not inserted into the under mandible. The irides are of a beautiful bay-brown, bounded by a light blue line almost as broad. Back from the latter, or the sclerotic, is another brown circle, nearly of the dimensions of the iris, but less deep in the colour. The external border of the eyes is white. The upper part of the head and sides of the face, are black and grey mixed. The chin is white. The upper part of the throat grey and white. The neck is of a dusky grey and white. The breast and belly are white, and have a glossy appearance. A blackish bar crosses the vent. The tail is very short. The shoulders and scapulars are of a mixture of black and ash colour, and most of the feathers are tipped with white. The inner coverts are white. The feathers on the back and rump are short, and of a dusky-ash colour, inclining to brown. The feet and legs are large

and strong, of a leaden colour on the fore, and black on the back parts.

As this description agrees in almost every particular with that given by ornithologists of the Colymbus Immer, with the exceptions of a slight difference in the size and weight, I am disposed to consider it as a young bird that had not attained the full growth. Indeed, there is a very obvious difference in the size of these birds, which, as it is more generally perceptible about the middle of winter than at any other period of the year, may fairly enough be referred to a difference of age.

Although the imber may be looked upon as one of those birds which is generally regular in its migration from Zetland for the purpose of breeding, yet I am disposed to believe that a few actually breed in this country. A clergyman, who has bestowed a good deal of attention in studying the habits and economy of birds, assures me, that he has, on different occasions, in the middle of summer, seen an imber-goose, accompanied by two young ones; and an intelligent fisherman told me, that he once surprised a bird, which he affirmed to be an imber, on its nest, on a small islet or *holm* several miles from the shore. The nest was carelessly constructed among tufts of high grass very near to the sea, and contained three large eggs of a dark olive colour, spotted with black.

From thus having ascertained that the Colymbus Immer can fly, and that it is regular in its disappearance from Zetland in the breeding season, we can easily reconcile the apparently opposite statements given by ornithologists respecting the diversity of situation in which it has been said to have been met with.

## XVIII. *Contributions to the British Fauna,*

By the Rev. John Fleming, F. R. S. E.

### 1. *Sorex fodiens,* or *Water Shrew.*

Brit. Zool. vol. i. p. 126.—Plate xi. No. 33.

Weight, 128 grains*. Length of the body, 3 inches. Tail, 2 inches. Above, black. Beneath, grey. Snout, long and a little compressed. Whiskers, long. Eyes small, concealed in the fur, with a small white spot above each. Ears likewise minute, with a paler tuft on the inside. In the middle of the throat, a black spot. A narrow stripe of black along the belly. At the base of the tail, a triangular black spot. Inside of the feet and legs white; the outer side black, con-

* Weight of another specimen recently obtained, 186 grains.

nected with the back. Tail pointed covered with very short hair, with a crest or ridge on the under side, of paler-coloured hair. The fore-teeth are two in number, and long, especially in the lower jaw.

Although usually described as an inhabitant of moist places, it would appear that this shrew occasionally prefers other situations. The specimen above described, was found dead on the top of a ridge of dry hills on the 3d September 1812. Mr Montagu appears likewise to have observed it in a similar situation, as appears from his remarks on this species.—(*Linn. Trans.* vol. viii. p. 276.)

This species chiefly frequents fields of clover and strong oats. It is by no means rare in the county of Fife.

Merret, in his *Pinax rerum naturalium Britannicarum*, p. 167. in all probability refers to this species, when enumerating the varieties of the common shrew, (Sorex araneus.) "Invenitur (he says) nigri vel fusci coloris, *et alter dorso nigro ventreque albo*, et parvus, griseus, et in partibus borealibus magnus, cauda brevi."

Our countryman Sir Robert Sibbald does not appear to have been acquainted with this animal, unless we suppose that he refers to it when he says, "varii mures sylvatici apud nos: quidam dorso nigro qui talpas occidit."

In the sketch of Caledonian Zoology, composed by Mr Pennant, and prefixed to the Flora Scotica

of Lightfoot, this shrew is mentioned as being an inhabitant of Scotland and the islands. He says it is the "*Lavellan* of some places; supposed to be noxious to cattle." In his British Zoology, however, he expresses himself with somewhat less confidence. When speaking of this animal, he says, "I *imagine* it to be the same that the inhabitants of Sutherland call the Water-Mole, and those of *Cathness the Lavellan;* which, the last imagine, poisons their cattle, and is held by them in great abhorrence."

It appears from Sibbald's description of the lavellan of Caithness, that Pennant has perhaps referred it too hastily to the species now under consideration. "Lavellan, (he says), animal in Cathanesia frequens, in aquis degit, *capite mustelæ sylvestri simile, ejusdemque coloris bestia est.*"—(*Scotia ill.* p. 11.) Noxious properties are ascribed to it. "Halitu bestiis nocet, remedium autem est si de aqua bibant in qua ejus caput coctum sit." The head of the water-shrew is by no means similar to the weasel, (*Mustela vulgaris L.*); neither is it a beast of the same colour. What then is the Lavellan of Caithness? Should it be considered as the Water Shrew?

The late Dr Walker appears to have been unacquainted with this animal as an inhabitant Scotland, as no place is assigned to it in his *Man Scotica*, lately published in his posthumo of Essays.—(Communicated 5th Dece )

### 2. *Pleuronectes punctatus.*

* Eyes on the left side of the head.

The length of the specimen in my possession, is five inches and a half from the nose to the point of the tail; and the breadth, two inches and six-eighths. Jaws nearly equal; teeth small; upper lip retractile and protrusile. Eyes middle-sized. The lateral line, which is rather indistinct, begins a short way behind the crown of the head, is much bent above the pectoral fin, and then proceeds in a straight line to the tail. The dorsal fin consists of seventy-nine rays, with the first of them longer than those which immediately follow. The pectoral fins contain nine rays; but in the under fin, one of the rays is remarkably short. The ventral fins consist of six rays. The anal fin is composed of sixty-eight rays. The caudal fin consists of seventeen rays, and is a little rounded.

The body and fins are closely covered with imbricated and denticulated scales. The denticles of the scales are from four to eight in number. Colour black, mottled with brown on the upper side, with a few scattered reddish spots. Beneath white, without any markings.

This specimen had not attained its full size. I found it on the 18th January 1810 in a fishing-boat, in Bixter-voe, Zetland.

This species appears to have been confounded by Gmelin, Shaw, and others, with the Whiff of

Ray. The characters which distinguish the two species, are sufficiently obvious, and have been pointed out with great perspicuity by Mr Donovan in his *History of British Fishes*, Plate li. when describing the Whiff of Ray.—(Communicated 9th December 1809.)

3. *Lepas fascicularis.*—Plate xvii. fig. 4.

Colour bluish-white, somewhat glossy. The first valve is narrow at the top, gradually swelling downwards to about one-third of its length from the base, where it forms an acute knob or apex; it then bends inwards, and increases in breadth to the base, where it is shaped like a hatchet. It has an elevated keel, which in some specimens extends from the knob to the top, and in others through the whole length of the shell. It is wrinkled, and the wrinkles are parallel to the margin, and diverge from the knob towards the edge. The large valves are obtusely triangular, with furrows parallel to the inner margin, and are divergingly streaked from the under point. They project a little at the base. The two upper valves are triangular, furrowed parallel to the inner margin, and are divergingly streaked from the upper point, which is a little produced and recurved. The valves are connected together by a transparent colourless skin. The peduncle is from half an inch to near a foot in length, thin, pellucid, smooth, and of a dusky colour when the animal is alive. The shell, which is thin, semi-

Fig 1.

Fig 3.

Fig 4.

E. Mitchell fecit.

transparent and brittle, is about an inch and a half in length.

This shell, like several of its congeners, is gregarious, and is usually found in clusters attached to a white gelatinous spherical substance, which adheres to various bodies.

The most curious circumstance in the history of this species, is the rapidity of its growth. The gelatinous substance from which the peduncles that support the shells proceed, is found adhering to various species of fuci, pieces of wood; and what is still more remarkable, I once observed full grown specimens adhering to the quill-feather of a gull. The feather seemed very entire and fresh. *Flustra membranacea* sometimes covers it all over, and so completely incloses the mouth of the shell, as to destroy the inhabitant. It is likewise infested with *Sertularia geniculata* *.

This shell was first observed by Ellis previous to the year 1776, and figured by him (*Ellis*, Zooph. tab. 15. fig. 6.) from a specimen from St George's



* Pallas, when speaking of Loefling's observations on Sertularia geniculata, says, "Vitam torpidissimam habere polypos dicit, ut acu tacti vix sensibilitatis dent signa." *Elenchus Zooph.* p. 119. This character of torpidity is by no means applicable to the S. geniculata of Ellis. When I touched the animals of this coralline with a needle, they speedily retired within the cavity of their cups; and when pulling away a small ascaris, which, by its motions, disturbed my observations with the microscope, it was instantly seized and devoured by one of these animals.

Channel. It has since been found on the English shores by the late Mr Bryer, and by Mr Montagu. I observed it among the Zetland Islands in 1808. It is thrown ashore in great abundance during the gales of autumn *.

Mr Donovan, in his British Shells, has figured a shell which he considered the same as the Lepas fascicularis of Ellis, but to which he gave the name of *L. dilata.* The figures of the two shells are essentially distinct, and never could have been given as representations of the same species. The pointed reflected apex of the upper valves, so characteristic of the Ellisian species, is not expressed in Donovan's figure, where the apex appears blunt. A short way below the upper extremity of the dorsal valve, there is represented in Donovan's figure, a sudden enlargement of the keel, which continues until the valve bends inwards to join the peduncle. In L. fascicularis, the keel gradually increases in size from the upper extremity of the dorsal valve, until it forms a small knob, where the valve bends inwards. Is the Lepas dilata of British Shells, therefore entitled to hold a place in the British Testacea?—(Communicated 9th December 1809.)

* Since writing the above, specimens of this lepas, adhering to the stems of Fucus nodosus, have been picked up, in the Minch, between the Mainland and Harris Isles, by my friend Robert Stevenson, Esq.

### 4. *Hirudo verrucosa.*

Encyclop. 7e Liv. des Pl. d'Hist. Nat.—Helminthologie, Pl. 52. fig. 5.

Head dilated; margin smooth, with six small tubercles or warts. Body round, thickest at the base, tapering towards the head, and composed of numerous warty rings. There are upwards of fifty large rings, with many intermediate smaller ones. These rings are studded in the middle with about twelve retractile warts. Tail nearly the size of the head, smooth and dilated. Length when stretched, nearly one foot.

Found on the skate and thornback in Zetland and Leith. It leaves a black mark behind; and after being removed, is very tenacious of life.

This species bears a near resemblance to the *H. muricata* of Linnæus. It may even prove to be the same, as I have never seen any specimen which I was convinced was the true H. muricata. The figure of H. muricata, as given by Linnæus in the *Museum Adolphi Friderici*, (and afterwards copied by Pennant into his *British Zoology,)* possesses two horns or teeth, which are very conspicuous, and the head is considerably smaller than than the tail. In the species above described, there are no appearances of horns or teeth, and the head is dilated, and nearly of the size of the tail.

The drawing of Bruguière, referred to above, exhibits a very just representation of the general appearance of the animal. He has omitted to delineate the small marginal tubercles of the mouth.

The genus *Hirudo*, as well as many of the genera of the class *Annelides*, is in great confusion. The present species, and *H. muricata*, certainly differ in habit and external characters from the fresh-water species of leeches, and ought to constitute a separate genus. Unless such subdivisions of many of the Linnean genera take place, each genus of the *Systema Naturæ* will assume the rank of an order, and the families will occupy the station of genera.—(Communicated 9th December 1809.)

### 5. *Echinus miliaris.*

Shell whitish, tinged with violet. The avenues of the pores in pairs, dividing the shell into five small, and five large spaces. The pores are placed in pairs, obliquely disposed in three rows. The smaller spaces have a row of protuberances, the seats of primary spines, on each side close to the pores, with the centre nearly smooth, or covered with very minute spines, divided by a zig-zag line down the middle. These spaces do not reach the top or vertex. The larger spaces are divided by a suture from the vertex to the mouth, more distinct than in the smaller spaces, with horizontal

sutures joining a line, which runs along the side of the pores, thus forming rhomboidal compartments. In the centre of each of these compartments, there is a large tubercle, with a few smaller ones. Thus, there are but two rows of spines in each of the spaces between the pores. The sides and middle of the larger spaces are nearly smooth. *Anus* vertical, circular, a little raised, closed by a coriaceous wrinkled muricated lid. Mouth beneath, central, circular, covered with a thick skin, beset with tufts of small spines.

This is a more depressed species than the *E. esculentus*. The spines are by no means so numerous, and a part of the spaces between the pores is smooth, which, in the other, is thickly set with spinules. The teeth resemble those of E. esculentus, but the jaws are a little more obtuse. The spines are stronger, blunt, finely streaked, and some of them are upwards of an inch in length.

This specimen was found in deep water at the mouth of Sellavoe, Zetland, where I have also observed the following species: *Echinus esculentus*, there called *Scaad* (scabbed) *man's head*. A species nearly allied to *E. spatagus*, termed the *sea-mouse*. *E. cidaris*, or *Piper*. The two last inhabit deep water. *E. pusillus*, often cast ashore, but never found with the spines. Professor Jameson found the *E. placenta*. I never observed the *E. lacunosus* in Zetland, although it is frequent in the Frith of Forth.—(Communicated 9th December 1809.)

### 6. *Lucernaria fascicularis.*

Plate xviii. fig. 1, 2.

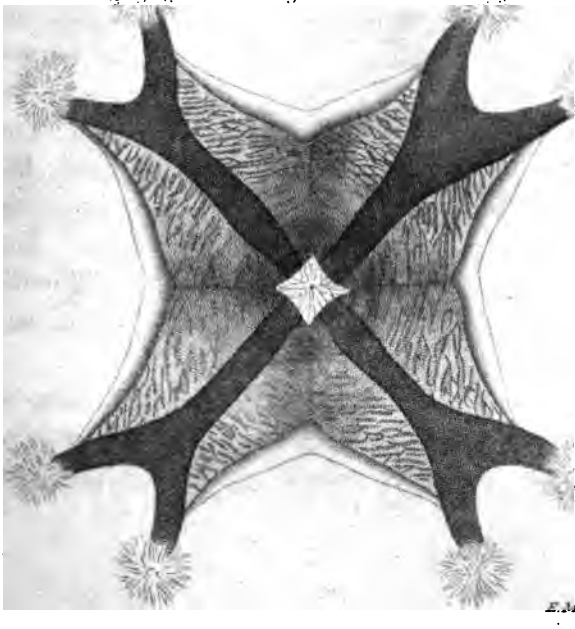
Substance gelatinous; colour dark-brown, nearly opake. Tail cylindrical, flexuous, wrinkled, extensile, and somewhat narrower at the base, where it adheres to broad-leaved *Fuci*. Body bell-shaped, sub-quadrangular, concave within. Margin divided into four arms, which are broad at the base, divided at the top, and concave within. On the top of each of the divisions of the arms, there is a fasciculus of tentacula, upwards of a hundred in number. The mouth is placed in the centre, and consists of a loose tubular membrane, sometimes four-notched at the tip, but often, at the pleasure of the animal, expanded, circular, or striated.

Internally, the animal appears to be divided into four compartments, reaching from the centre to the margin between the arms. The divisions are formed by a thin membrane from the four corners of the mouth. On each side of these divisions, a thick corrugated band extends from the centre, almost to the border of the margin. The bands are the intestines of the animal. The inside of the mouth contains numerous white filaments.

The animal contracts itself into various shapes. It moves the tentacula very quickly, especially if muddy water is poured upon it. Although

Fig. 1.

Fig. 2.



E. Mitchell, sculpt.

I have kept it alive several days, I have never observed it in an upright position. It in general hangs downwards, as expressed in the figure, sometimes, however, it is nearly horizontal.

It is chiefly found on the leaves of *Fucus digitatus*, and *F. esculentus*, which grow in deep water. It is common in Zetland.

At first I was disposed to consider this species as the *Lucernaria quadricornis* of Müller, (Zool. Dan. i. tab. 39. fig. 1.); but a more careful comparison of the figure and description with the Zetland specimens, has convinced me of the propriety of viewing them as distinct species. In *L. quadricornis*, the branches of the arms are represented as terminating in a fasciculus of about forty tentacula; whereas, in *L. fascicularis*, the tentacula are upwards of a hundred in number.—(Communicated 9th December 1809.)

### 7. *Caryophyllia cyathus.* (Lamark.)

*Madrepora cyathus.—Ellis*, Zooph. p. 184. tab. 28. fig. 1—4.

Coral white, hard, striated on the outside, and rough. Margin denticulated by the plates of the gills. Star oval, containing forty or fifty gills, with an equal number of intermediate smaller ones; the latter reaching to the margin, but not to the centre as the larger ones do. In the centre of the star, there is a prominent ridge in the direction of its greatest diameter. This ridge is com-

posed of curled plates on each side, of a substance similar to the plates of the gills.

I have only observed two specimens of this zoophyte, which I found in a fishing-boat in the Island of Papa Stour, Zetland, the 3d August 1808. They were taken up from deep water on the cod-lines in the fishing ground off Foulah. The largest of the two specimens, was half an inch in height, six-tenths in length, and four-tenths in breadth. They were both attached to a dead shell of *Pecten opercularis*, along with *Balanus intertexa*, and *Serpula tubularia*.

### 8. *Fungia turbinata.* (Lam.)

*Madrepora turbinata.*—Lin. Syst. Nat. p. 1272—337. 6. Amœn. Acad. vol. i. p. 190. fig. 1, 2, 3, 4, 7.

In the same boat in which I found the Caryophyllia cyathus, I likewise picked up a dead specimen of this coral somewhat defaced. It was of the shape of an inverted cone, with the base pointed. The star appeared to have been concave with entire gills. It was about five-tenths of an inch in height, and about the same in breadth at the top.

From its shape, it appears probable, that it grows with its base fixed in the sandy bottom of the sea, as Pallas formerly conjectured.

### 9. *Flustra Ellisii.*

**Pl. xvii. fig. 1. nat. size, fig. 2. mag., fig. 3. side view.**

Substance firm, brittle, and gritty when dry. Colour yellowish-white. The base consists of small horny tubuli, by which it is fixed. These tubuli unite, and form narrow linear leaves dichotomously branched. The branches are somewhat rounded and celliferous above. The under side is carinated, and destitute of cells. The tubuli or fibres of which the substance is composed on the under side, can be distinctly seen diverging from the keel towards the edge of the leaf, and forming two small denticles and a bristle on the upper side of each lateral cell. These bristles are about three times the length of the diameter of the branches, and are finely denticulated on one side. The cells are oval, and obliquely disposed in two or three rows.

This Flustra was brought up by the cod-lines from a hundred fathoms water, off Stenhouse, in the parish of Northmavine, Zetland, in July 1808. It was growing on an aged specimen of *Eschara cervicornis*, in company with *Retepora cellulosa*.

As this Flustra appears to be a new species, I have named it in honour of Mr Ellis, that able investigator of the natural history of Zoophytes, whose works exhibit a striking example of perseverering industry, and accurate investigation.

## XIX. *Description and Analysis of a new Species of Lead-Ore from India.*

By Thomas Thomson, M. D. F. R. S. L. & E. F. L. S. Fellow of the Geological Society, of the Wernerian Society, and of the Imperial Chirurgo-Medical Academy of Petersburgh.

*(Read 12th February 1814.)*

The ore which constitutes the subject of this paper, was brought by Dr Heyné from Madras, where it is sold in the shops for medical purposes. He thinks it probable that it comes originally from Malacca, or the Island of Sumatra. As it differs in its constituents from every species of ore hitherto observed in Europe, it will not be amiss to lay a description of it, together with the result of its analysis, before the public.

The external colour of the specimen which I examined, was blackish-blue, with green stains here and there, indicating very clearly, the presence of copper. When broken, it exhibits the

appearance of steel-grained galena, only the colour is darker, and it shews the granular concretions which distinguish that variety of sulphuret of lead. But, in a few days, this fracture tarnishes, loses its metallic lustre, and speedily becomes similar to the external surface of the specimen.

The fracture is small-grained uneven. The external lustre glimmering, and semi-metallic. The internal lustre splendent and metallic. Soft, easily scratched by a knife. Streak, lead-blue. Rather sectile. Specific gravity, 6.590. But Dr Heyné informed me, that he had found pieces as light as 4.9.

Strong nitric acid acts upon this ore, when reduced to powder, with great violence; but when the acid is diluted with water, the action is scarcely perceptible.

A hundred grains of the ore in the state of powder, were treated with an ounce measure of strong nitric acid. The action was so violent, that I was obliged to moderate it by the addition of water. When this portion of acid ceased to act, it was decanted off, and an additional portion substituted in its place. After two days, all action was at an end. Part of the ore was dissolved, and part was in the state of a white powder. This white powder being separated by the filter, washed and dried in the open air, weighed 58.5 grains. When exposed to the heat of a lamp on a watch-glass, it gave out fumes of sulphur, and the weight was reduced to

54.8 grains. The 3.7 grains driven off, I consider as sulphur.

The white powder was now exposed to a red heat in a platinum crucible, but it did not lose any weight. Before the blow-pipe, upon charcoal, it was speedily reduced, and a button of metallic lead obtained. It was easy to recognize by these properties, that the powder was sulphate of lead.

The acid liquor being evaporated nearly to dryness, an additional portion of white powder separated, which, being washed and dried, weighed 16.6 grains. It was likewise sulphate of lead.

Thus, 100 grains of the ore yielded 71.4 grains of sulphate of lead. Now, this salt is a compound of

| | |
|---|---|
| Yellow oxide of lead, | 52.61 |
| Sulphuric acid, - | 18.79 |
| | 71.40 |

From the table given in the *Annals of Philosophy*, vol. ii. p. 42., it is easy to see that 52.61 grains of oxide of lead, contain 48.849 grains of lead. From the same table, we may ascertain, that 18.79 grains of sulphuric acid contain 7.516 grains of sulphur.

The liquid from which the last portions of sulphate of lead had been separated, being set aside for a few days, let fall small tetrahedral crystals of a white colour, which I recognized by their form to be nitrate of lead. They weighed 2.13 grains, and contained 1.21 grains of lead. Thus, the

whole lead obtained from the 100 grains of ore, amounted to 50.059 grains.

The solution being mixed with some nitrate of barytes, become slightly muddy, and let fall a white powder, insoluble in nitric acid, and therefore sulphate of barytes. It weighed 0.8 grain, and contained 0.112 grain of sulphur. The presence of sulphuric acid, in a solution from which nitrate of lead had separated in crystals, is curious. I do not see how it can be accounted for, unless we suppose Berthollet's principle of the effect of mass to be to a certain amount true. For there was present in the liquid, an enormous excess of nitric acid, when compared with the quantity of sulphuric acid. Thus, the whole sulphur obtained from the 100 grains of ore, amounted to 11.328 grains.

The nitric acid solution, which had a bluish-green colour, was now mixed with 90 grains of sulphuric acid, and distilled in a retort almost to dryness, to get rid of the nitric acid. The residue was dissolved in water, and a plate of zinc being introduced, was allowed to remain till the liquid lost entirely its blue colour, and assumed the light-green tinge, which indicates the presence of iron. Diluted muriatic acid was now poured upon the plate of zinc, till it was completely dissolved. The copper thrown down by this process, being dried and weighed, was found to amount to 32.5 grains.

A plate of fresh zinc was introduced into the green solution, and allowed to remain till the colour was entirely removed. Yellowish-red flocks were thrown down, which being washed, dried, and weighed, amounted to 2 grains. Being dissolved in muriatic acid, and mixed with prussiate of potash, the whole was precipitated in the state of Prussian blue. Hence it consisted of red oxide of iron. But 2 grains of red oxide of iron, are equivalent to 1.37 grain of iron.

Thus it appears, that the constituents of the ore were as follows:

| | |
|---|---|
| Lead, - | 50.059 |
| Copper, - | 32.500 |
| Iron, - - | 1.370 |
| Sulphur, - | 11.328 |
| Loss, - - | 4.743 |
| | 100.000 |

If we conceive the loss in the preceding analysis to have been sulphur, which I think probable from the violent action of the first portion of nitric acid, the ore was nothing else than a mixture or combination of the sulphurets of lead, copper, and iron, in the following proportions:

| | | |
|---|---|---|
| Sulphuret of lead, | - | 57.269 |
| Sulphuret of copper, | - | 40.850 |
| Sulphuret of iron, | - | 2.190 |
| | | 100.309 |

That this ore is not a mere mechanical mixture of these sulphurets, I conceive proved by this circumstance. I attempted in vain to separate the sulphuret of copper from the sulphuret of lead, by washing the powdered ore upon an inclined plane. Yet the specific gravity of these two sulphurets, is so different, that their mechanical separation ought to be easy, unless they be chemically combined. Now, it deserves attention, that the ore, (neglecting the small quantity of sulphuret of iron, which is probably accidental,) consists of one integrant particle of sulphuret of lead, combined with two integrant particles of sulphuret of copper. Hence I am disposed to consider this ore as constituting a new species of lead-ore,—a species, however, of comparatively little value in a metallurgic point of view; because lead and copper are mutually injurious to each other, and it would be difficult to devise cheap methods of separating them.

As this ore has only been met with in apothecaries shops, and as we are ignorant of any mine of it actually existing, it may be supposed perhaps to be an artificial combination. From the appearance of the specimen which I examined, no

such conclusion could be drawn. It had all the characters of a natural production. At the same time, it would be worth while to make a few experiments, in order to determine whether a similar substance could be obtained by melting together sulphurets of lead and copper in the requisite proportions.

## XX. *Notice concerning the Structure of the Cells in the Combs of Bees and Wasps.*

By Dr Barclay.

*(Read 18th January 1812.)*

Having inquired of several naturalists, whether or not they knew any author who had mentioned, that the partitions between the cells of the honeycomb were double, and whether or not they had ever remarked such a structure themselves; and they having answered in the negative; I now take the liberty of presenting to the Society pieces of honeycomb, in which the young bees had been reared, upon breaking which, it will be clearly seen that the partitions between different cells, at the sides and the base, are all *double;* or in other words, that each cell is a distinct, separate, and in some measure an independent structure, agglutinated only to the neighbouring cells; and that when the agglutinating substance is destroyed, each cell may be entirely separated from the rest.

I have also some specimens of the cells formed by wasps, which show, that the partitions between them are also double, and that the agglutinating substance between them is more easily destroyed than that between the cells of the bee.

I confess, that I do not know whether this structure has been observed by others before me; but whether it has or not, I claim no merit for the discovery, as I was led to remark the structure by mere accident, and not from any previous investigation.

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